



Beckman[®]

Operating and Servicing Manual

Electronic Instruments Division

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Model # **6015A** Serial # **151**

Application _____

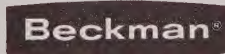


PR Seelman

MODELS
6013A, 6014A, 6015A
Reversing Accumulators

(PREFIX 500)

SERIAL No. 151



INSTRUMENTS, INC.

ELECTRONIC INSTRUMENTS DIVISION

RICHMOND, CALIFORNIA • 94804

11/17/67 Beckman Changes:
01d

BII No. 015-436097

Fwd Rev
DCU Bnd.

{ INDTR52208
{ F 5735 or TI712A

New

RCA 4034G or TISK 5198
TI 741A

WARRANTY

Instruments sold by Electronic Instruments Division, Beckman Instruments, Inc., (hereafter called "the Company") are warranted only as stated below.

Subject to the exceptions and upon the conditions specified below, the Company agrees to correct, either by repair, or, at its election, by replacement, any defect of material or workmanship which develops within one year after delivery of the instrument to the original purchaser by the Company or by an authorized representative, provided that investigation and factory inspection by the Company discloses that such defect developed under normal and proper use.

The exceptions and conditions mentioned above are the following:

- (a) Some components and accessories by their nature are not intended to, and will not, function one year. If any such component or accessory manufactured by the Company and part of the item sold fails to give reasonable service for a reasonable period of time, the Company will, at its election, replace or repair such component or accessory. What constitutes reasonable service and what constitutes a reasonable period of time shall be determined solely by the Company after the Company is in possession of all the facts concerning operating conditions and other pertinent factors and after such component or accessory has been returned to the Company, transportation prepaid.
- (b) All instruments claimed defective must be returned to the Company, transportation charges prepaid, and will be returned to the customer with the transportation charges collect, unless the item is found to be defective in which case the Company will pay all transportation charges.
- (c) The Company makes no warranty concerning components or accessories not manufactured by it, such as tubes, fuses, batteries, etc. However, in the event of the failure of any component or accessory not manufactured by the Company, the Company will give reasonable assistance to the purchaser in obtaining from the respective manufacturer whatever adjustment is reasonable in the light of the manufacturer's own warranty.
- (d) Except as stated above, the Company makes no warranty, express or implied (either in fact or by operation of law), statutory or otherwise; and, except to the extent stated above, the Company shall have no liability under any warranty, express or implied (either in fact or by operation of law), statutory or otherwise.
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Claims for damage in shipment should be filed promptly with the transportation company.

All correspondence concerning the instrument should specify the model and serial number. This information appears on the company nameplate. Any inquiry concerning details of operation, possible modifications, etc., should be addressed to the Sales Department, Electronic Instruments Division of Beckman Instruments, Inc., Richmond, California, 94804.

REPAIR SERVICE

Experienced service personnel and special test equipment are available at any of three Regional Service Centers and the factory to perform any necessary repairs. Every effort will be made to expedite the repair of instruments returned for servicing. To obtain warranty service contact your nearest Beckman Service Office, which will give you the necessary instructions for returning the instrument. Beckman Service Offices now in operation are shown on the bottom of this sheet. Instruments returned for service will be sent to the Beckman Service Office, transportation charges prepaid. The instrument will be returned to the purchaser with transportation charges prepaid.

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Beckman Instruments, Inc.
Electronic Instruments Division
2200 Wright Avenue
Richmond, California 94804

CENTRAL
Beckman Instruments, Inc.
Electronic Instruments Division
Post Office Box 66204
Chicago, Illinois 60666

EASTERN
Beckman Instruments, Inc.
Electronic Instruments Division
12050 Tech Road
Montgomery Industrial Park
Silver Springs, Maryland 20904

DISTRICT SERVICE OFFICES

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Fullerton, California 92634

Sahara Office Center, Suite 116
3313 Memorial Parkway, S.
Huntsville, Alabama 35801

U.S. Highway #22 at Summit Road
Mountainside, New Jersey 07091

MANUAL REVISIONS

Beckman Instruments, Inc. is continually striving to provide better quality in its products. As a result, changes are initiated to improve performance and specifications.

Several changes may have been incorporated in your instrument since the manual was last printed. If this is the case, may we impose on you to make these changes to your copy of the manual? All changes are given in the form of addenda, one addendum for each change. They are printed on green-colored paper and inserted, in letter sequence, after the title page.

Addenda you should have in your manual are checked in the following tables.

NOTE

The prefix number denotes a generation of manuals. All addenda for a certain prefix number are incorporated in the manual before reprinting and the number increased by one (e.g., "Prefix 500" becomes "Prefix 501").

MODELS 6013A, 6014A, & 6015A

[illegible]

6000 SERIES OPTIONS

DA

Add'm	Change

DP

Add'm	Change

DJ

1	Acces'y Com: Rev. H to G
2	Bi-Qui. DCU (Fwd. Only) Rev. B to A
3	Bi-Qui. DCU (Fwd./Rev.) Rev. C to B

D3

D5

DK

DM

D7

A	Input Ampl. Dec. Sensitivity Rev. D to E
"	Input Ampl. Inc. Sensitivity Rev. E to F

D8

DO

MODELS 6013A, 6014A, 6015A

Please note the following errors in your manual:

- 1) "DESCRIPTION - Models 6013A, 6014A, 6015A", Page 3, Table 2:

The last entry in column labelled "Glow-Tube Socket Pin Number" should be 3 instead of 12.

- 2) The revision letter for the Preset Board Component Layout, Page 5-5 (dwg. no. C426025) and Preset Schematic Diagram, Page 5-5a, (dwg. no. D425936) should be "D" instead of "E".

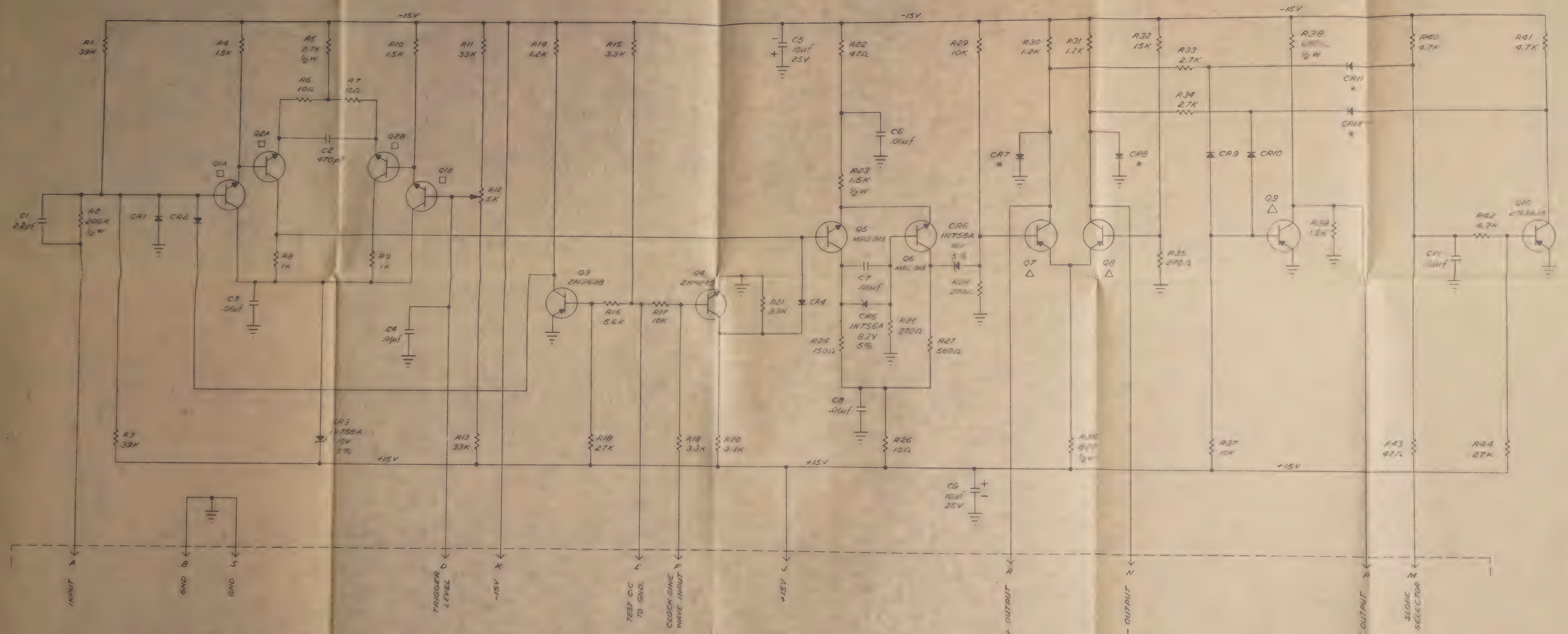
INPUT DIFFERENTIAL AMPLIFIER

TEST SECTION

SHAPER

INVERTER

SLOPE SELECTOR



- NOTES:
- * DIODES ARE BECKMAN SPEC. A755-420293 UNCODED " " A755-431324 UNLESS OTHERWISE NOTED.
 - TRANSISTORS ARE BECKMAN SPEC. A755-851855 " " A755-425735
 - RESISTORS ARE 1/2W 5% UNLESS OTHERWISE NOTED.

6000A C887-435018
 HEAT ASSY. USED ON
 APPLICATION

UNLESS OTHERWISE SPECIFIED		BY	DATE	TITLE	PART NO.	DESCRIPTION	QTY
TOLERANCES		DRAWN A. S. 5-67		SCHEMATIC, 1 VOLT INPUT AMPLIFIER			
X ± .030 ANGULAR ± 0° 30'		CHKD A. S. 5-67		Beckman INSTRUMENTS, INC.			
XX ± .020 MACH SURF		ENGR A. S. 5-67		ELECTRONIC INSTRUMENTS DIVISION			
THREADS CLASS 2A OR 2B		APPD A. S. 5-67		RICHMOND, CALIFORNIA			
REMOVE BURRS & SHARP EDGES .020 MAX		MATERIAL		THIS DOCUMENT CONTAINS PROPRIETARY INFORMATION OF BECKMAN INSTRUMENTS, INC. AND IS LOANED SUBJECT TO THE CONDITION THAT THE INFORMATION IS BE KEPT IN CONFIDENCE. IT IS NOT TO BE REPRODUCED OR COPIED IN WHOLE OR IN PART AND IS NOT TO BE USED OR INCORPORATED IN ANY PRODUCT, EXCEPT UNDER AN EXPRESS WRITTEN AGREEMENT WITH BECKMAN INSTRUMENTS, INC.			
MACH. SURF. FLAT WITHIN .001 IN/IN		FINISH		D 020-435018 A			
OTHER SURF. FLAT WITHIN .005 IN/IN		SCALE		SIZE SHEET / OF / REV			
CONCENTRICITY MACH. SURF. TIE WITHIN 1/4 SUM OF DIA. TOL'S, .001 MIN		DO NOT SCALE DRAWING					

D 020-435018
 DWS NO.

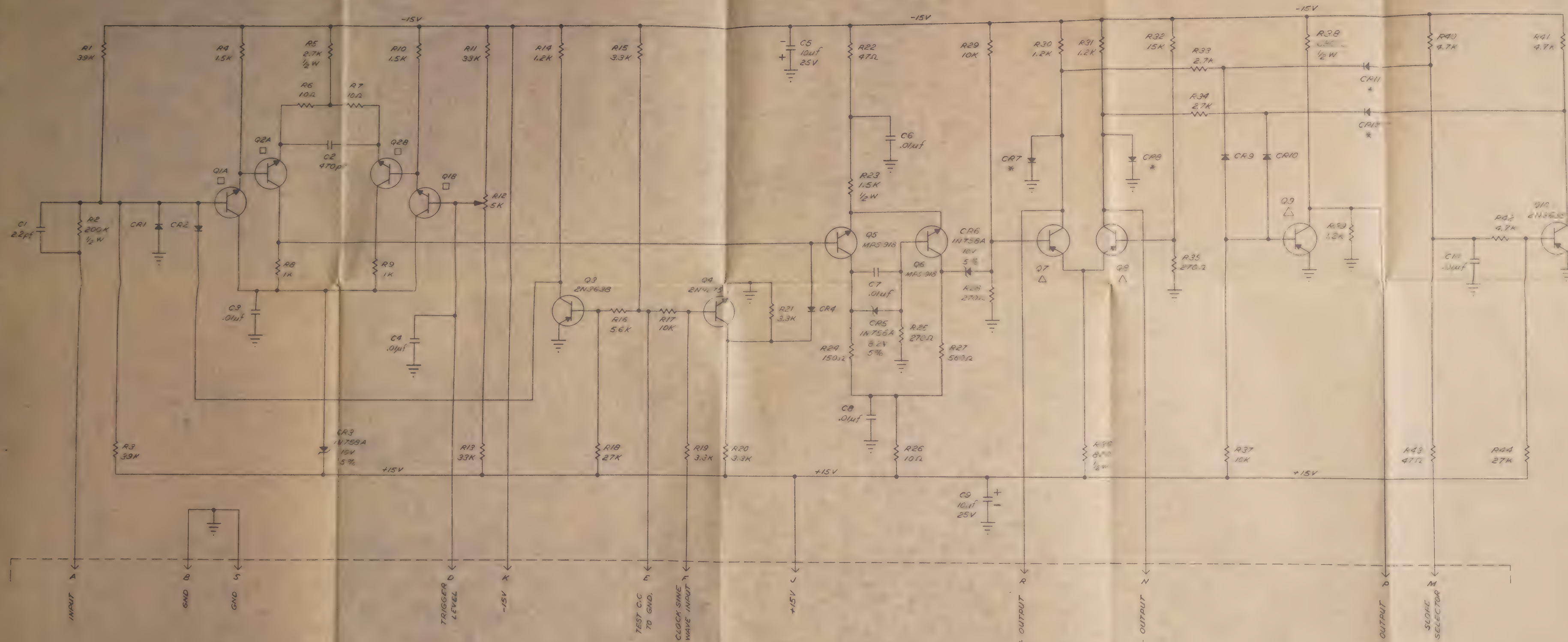
INPUT DIFFERENTIAL AMPLIFIER

TEST SECTION

SHAPER

INVERTER

SLOPE SELECTOR



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- 1 * DIGDES ARE BECKMAN SPEC. A755-420893 UNCODED " " A755-431324 UNLESS OTHERWISE NOTED.
- 2 □ TRANSISTORS ARE BECKMAN SPEC. A755-851855 " " A755-425735
- 3 RESISTORS ARE 1/4W, 5% UNLESS OTHERWISE NOTED

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X ± .030 ANGULAR ± 0° 30'		CHKD <i>W. J. J.</i>	6-67		ELECTRONIC INSTRUMENTS DIVISION		
XX ± .005		ENGR <i>W. J. J.</i>	6-67		RICHMOND, CALIFORNIA		
XXX ± .005		APPD <i>W. J. J.</i>	6-67		THIS DOCUMENT CONTAINS PROPRIETARY INFORMATION OF BECKMAN INSTRUMENTS, INC. AND IS LOANED TO YOU BY BECKMAN INSTRUMENTS, INC. IT IS TO BE RETURNED TO BECKMAN INSTRUMENTS, INC. WHEN REQUESTED. IT IS NOT TO BE REPRODUCED OR COPIED IN WHOLE OR IN PART AND IS NOT TO BE USED OR INCORPORATED IN ANY PRODUCT EXCEPT UNDER A LICENSE WRITTEN AGREEMENT WITH BECKMAN INSTRUMENTS, INC.		
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MACH. SURF. FLAT WITHIN .001 IN/IN.							
OTHER SURF. FLAT WITHIN .001 IN/IN.							
CONCENTRICITY MACH. SURF. TIR WITHIN 1/4 SUM OF DIA TOLS. .001 MIN.							
DO NOT SCALE DRAWING							

020-435018
DWS, INC.

SECTION 6 APPENDICES

Logic Symbols and Typical Circuits

Options

DESCRIPTION

GENERAL

Except as noted in the following paragraphs, all information in the Models 6013, 6014, and 6015 instruction manual applies to the Models 6013A, 6014A, and 6015A instruction manual.

INTRODUCTION

The five-digit front panel edge-lit display has been replaced by a group of five numerical glow-tube indicators (see figure 1). Table 1 gives the specifications of these glow-tubes.

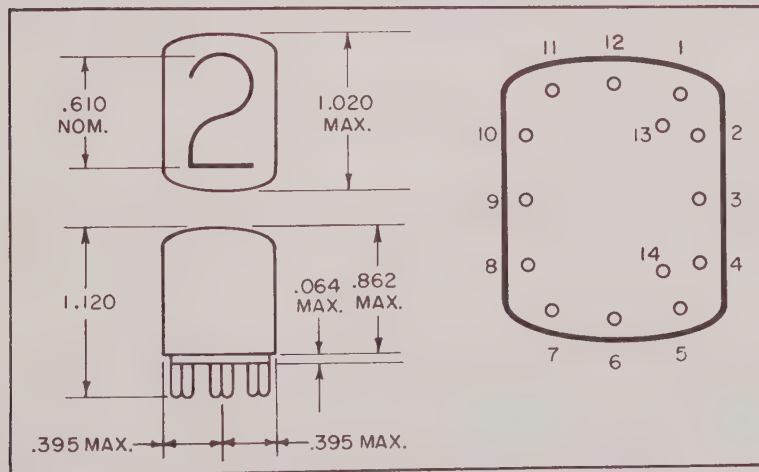


Fig. 1. Glow-Tube Specifications

Table 1. Glow-Tube Specifications

Type		B5991 Ultra Long Life Rectan- gular	PIN CONNECTIONS	
			Pin No.	Characters
Absolute Ratings			1	Anode
Ionization Voltage (Max)	170Vdc		2	Numeral 0
Supply Voltage (Min)	170Vdc		3	Numeral 9
Cathode Current (Peak)	3.5 ma		4	Numeral 8
Test Conditions			5	Numeral 7
			6	Numeral 6
			7	Numeral 5
			8	Numeral 4
			9	Numeral 3
			10	Numeral 2
			11	Numeral 1
			12	Internal Connection
Supply Voltage	180Vdc		13	Internal Connection
Series Resistor	8.2 K		14	Internal Connection
Cathode Current (Min)	1.5 ma			
Cathode Current (Max)	3.0 ma			

OPERATION

Figure 2-1 in the appended instruction manual is no longer applicable.

THEORY OF OPERATION

The five count-chain DCU's (decimal counting units) described in paragraph 3.6 of the appended instruction manual, have been replaced by five DCU's which are designed to drive glow-tube indicators. Refer to the Biquinary DCU (Forward-Reverse, With Readout) Schematic Diagram drawing no. D427999.

The basic counting circuitry in these DCU's is the same as that used in the previous DCU's. However, the output from this DCU consists of ten lines in decimal code; each line drives a single cathode in the glow-tube indicator associated with the DCU. These ten lines are derived from the basic counting circuitry via ten buffer amplifiers. Table 2 shows the interconnections between the DCU and the glow-tube indicator. This table replaces figure 3-9 in this instruction manual.

Table 2. DCU to Glow-Tube Interconnections

Glow-Tube Numeral	DCU Pin Number	Glow-Tube Socket Pin Number
0	3_R	2
1	4_R	11
2	5_R	10
3	6_R	9
4	7_R	8
5	8_R	7
6	9_R	6
7	10_R	5
8	11_R	4
9	12_R	3

SERVICING

A change has been made in the power supply; the -32 volt dc supply has been replaced by a +175 volt dc supply, which is used to energize the anodes of the glow-tube indicators.

-Description-

Figure 2 replaces figure 4-1 in the appended instruction manual; figure 3 replaces figure 4-2 in the appended instruction manual.

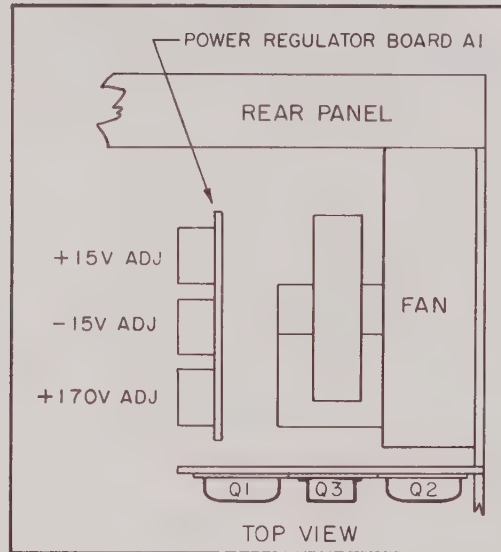


Fig. 2. Location of Power Supply Adjustments

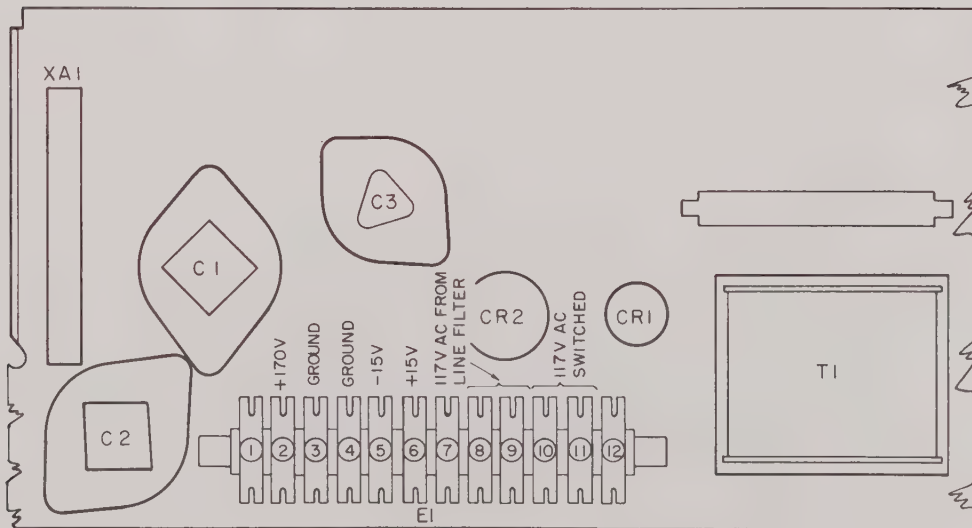


Fig. 3. Power Supply Test Points

INSTRUCTION MANUAL

MODELS 6013, 6014, 6015
ACCUMULATORS

NOTE

This manual consists of two parts:

Part A - Model 6013

Part B - Models 6014, 6015

Much of Part A is applicable to Part B.

Beckman[®]

INSTRUMENTS, INC.

ELECTRONIC INSTRUMENTS DIVISION

2200 WRIGHT AVENUE
RICHMOND, CALIFORNIA • 94804
(415) 526-7730; TWX: 910-382-8125

August 1965

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The Company reserves the right to make changes in design at any time without incurring any obligation to modify equipment previously purchased to conform to subsequent design changes.

The logo consists of the word "Beckman" in a bold, sans-serif font, enclosed within a rectangular border.

INSTRUMENTS, INC.

ELECTRONIC INSTRUMENTS DIVISION

RICHMOND, CALIFORNIA • 94804

CONTENTS

PART A:

	Page
SEC. 1 INTRODUCTION	
1.1 General	A1-1
1.2 Specifications	A1-1
1.3 Options	A1-2
SEC. 2 OPERATION	
2.1 General	A2-1
2.2 Applying Power	A2-1
2.3 Modes of Accumulation	A2-2
2.4 External Controls and Connectors	A2-3
2.5 Internal Controls	A2-5
SEC. 3 THEORY OF OPERATION	
3.1 Introduction	A3-1
3.2 General Operation	A3-1
3.3 Input Amplifiers	A3-3
3.4 Forward and Reverse Logic Board	A3-4
3.5 Accumulator Control Board	A3-12
3.6 Decimal Counting Units (DCU's)	A3-13
SEC. 4 SERVICING	
4.1 General	A4-1
4.2 Adjustments	A4-2
4.3 Troubleshooting	A4-4

PART B:

SEC. 1 INTRODUCTION	
1.1 General	B1-1

continued. . .

	Page
1.2 Specifications	B1-1
1.3 Options	B1-1
SEC. 2 OPERATION	
2.1 General	B2-1
2.2 External Controls and Connectors	B2-1
2.3 Remote Connector J2	B2-6
2.4 Operating Procedure	B2-7
SEC. 3 THEORY OF OPERATION	
3.1 General	B3-1
3.2 Theory of Operation of the Basic Reversing Accumulator	B3-1
3.3 Preset Boards	B3-1
SEC. 4 SERVICING	
SEC. 5 PARTS LIST	
APPENDIX	
COMPONENT LAYOUT DRAWINGS	
Accumulator Control P.C. Board	D425470
Forward-Reverse P.C. Board	D425255
Input Amplifier P.C. Board	C425611
DCU P.C. Board	C426102
Regulator P.C. Board	C423795
Preset P.C. Board	C426025
Outline Drawing	65-C-6000-001

continued. . .

DIAGRAMS

Accumulator Control Schematic	D425094
Forward-Reverse Schematic	D425254
Input Amplifier Schematic	D425640
Preset Schematic	D425936
Bi-Quinary Schematic	D426096
Model 6014 Preset Switch Wiring Diagram	D426123
Model 6015 Preset Switch Wiring Diagram	D426342
Power Supply Schematic	C423573

ILLUSTRATIONS

Figure		Page
2-1	Model 6013 Front Panel	A2-1
2-2	Rear Panel Connectors	A2-1
3-1	Model 6013 Functional Blocks	A3-2
3-2	Slope Selection Logic Diagram	A3-3
3-3	Amplifier Input and Output Signals	A3-4
3-4	Sign Indication Logic of Forward-Reverse Logic Board	A3-5
3-5	Forward-Reverse Logic of F-R Logic Board	A3-8
3-6	Example of Accumulator Operation in X - Y Mode	A3-11
3-7	Accumulator Control Board Logic Diagram	A3-13
3-8	Forward-Reverse Decimal Counting Unit Logic Diagram	A3-16
3-9	Lamp Block - DCU Interconnection	A3-17
4-1	Location of Power Supply Adjustment	A4-3
4-2	Location of Power Supply Test Points	A4-3
2-1	Model 6014 Front Panel	B2-1
2-2	Model 6015 Front Panel	B2-2
3-1	Block Diagram	B3-6
3-2	Preset Boards Inputs and Outputs	B3-2

continued. .

Figure		Page
3-3	Preset Board Logic Diagram	B3-2
3-4	Preset Select Switch Schematic	B3-3
3-5	N-PRESET Outputs	B3-4

TABLES

Table		
1-1	Specifications	A1-1
1-2	Options with Models 6013, 6014, 6015	A1-2
2-1	Modes of Accumulation	A2-2
2-2	Front Panel Controls (Model 6013)	A2-3
2-3	Rear Panel Connectors	A2-3
2-4	Model 6013 Remote Connector Pin Numbers	A2-4
3-1	Forward-Reverse Logic Showing Sign Changes	A3-7
3-2	Forward-Reverse Operation	A3-12
3-3	Technical Characteristics of the DCU	A3-14
3-4	Bi-Quinary Decimal Code	A3-15
4-1	Recommended Test Equipment	A4-1
4-2	Printed Circuit Boards Used in 6000 Series Accumulators	A4-2
2-1	Front Panel Controls (Models 6014, 6015)	B2-2
2-2	Rear Panel Connectors	B2-5
2-3	Models 6014 and 6015 Remote Connector Pin Numbers	B2-6

PART A

SECTION 1 INTRODUCTION

1.1 GENERAL

The Beckman Model 6013 is a high-speed, solid-state reversing accumulator. It is a five-digit in-line readout instrument with a maximum counting rate of 2 mc and an absolute storage capacity of 99,999.

The Model 6013 can accept either one or two lines of input data, and can add or subtract a single line of data from a prior accumulated sum. It can accept two lines of input data and either add both lines or add one line and subtract the other line from a prior accumulated sum. For any of these operating modes, the new sum is algebraically stored and displayed on a five-digit in-line edge lit readout.

The instrument can provide five digits of four-line binary coded decimal output to accessory recorders.

Input connectors and minor controls are located on the rear of the instrument or are internal adjustments.

1.2 SPECIFICATIONS

Specifications for the Model 6013 are listed in Table 1-1.

Table 1-1. Specifications

Functions	Adds and subtracts counts to any accumulated sum.
Counting Rate	Counts input signal dc to 2 mc in $\bar{X}$ sense ($\bar{X}$) mode. Counts random input pulses as closely spaced as $0.5 \mu s$ in $\bar{X}$, $X+Y$, and $X-Y$ modes.

continued. . .

Table 1-1. Specifications - continued

Display	
Data Word	5 Digits, 00000 to 99999 in-line, edge-lit readout. Display is continually updated during counting.
Sign Indication	Positive and negative symbols (+ and -) indicating sign of accumulated sum is displayed at left of numerical readout.
GATE OPEN Indication	Indicates condition of count gate (open or closed).
Trigger Adjustment	±10 V internal adjustment.
Environmental	
Temperature	Operating: 0°C to 55°C Storage: -18°C to 75°C
Humidity	Operating: 85% RH; 40°C, 24 hours.
Altitude	Operating: 10,000 ft; storage 50,000 ft.
Power Requirements	115Vac; 50-60 cycles, 56 watts.
Dimensions	3-1/2" H x 19" W x 17" D
Weight	28 lbs.

1.3 OPTIONS

Table 1-2 lists the options available with Model 6013.

Table 1-2. Options with Models 6013, 6014, 6015

Option	Description
DE	Relay racks. On request.

continued. . .

Table 1-2. Options with Models 6013, 6014, 6015 - continued

Option	Description
DH	230V ac line voltage. Power transformer wired for 230 v $\pm 10\%$, 50 to 60 cps.
DJ1 \$100	Binary coded decimal output. Five digits of four-line 1-2-4-8 BCD output at rear panel 50-pin connector, Amphenol type 57-40500. Includes "+" sign (1) and "-" sign (0). Binary "0" is -10 v to ground, 0.2 ma maximum; binary "1" is -0.8 v, 5 ma maximum. With option DM, 6th digit and OVERFLOW ("0" no overflow or "1" overflow) is included.
\$190 DM	Addition of 6th digit and OVERFLOW to display.
DN	Remote display. Data output for remote display available at rear-panel connector. Includes cover plate for vacated front panel display. (Mating connector, cable, and cable length requirements available on request.)
DO	Model 6014 only: Addition of relay output at preset coincidence. Model 6015 only: Addition of relay output at each preset coincidence.
\$150 DP	Anticoincidence to accommodate absolute coincidence of X and Y inputs; 1 mc maximum at each input.
DQ	Tilt foot handles to replace rack-handle adaptors.

SECTION 2

OPERATION

2.1 GENERAL

The Model 6013 can accept two lines of input data, X and Y. These inputs are algebraically added to any prior accumulated sum according to the desired mode of operation.

Figure 2-1 shows the front-panel controls and readout display. X and Y input connectors on the standard instrument are located on the rear panel, as shown in Figure 2-2. (Rear panels for the Models 6013, 6014, and 6015 are identical.)

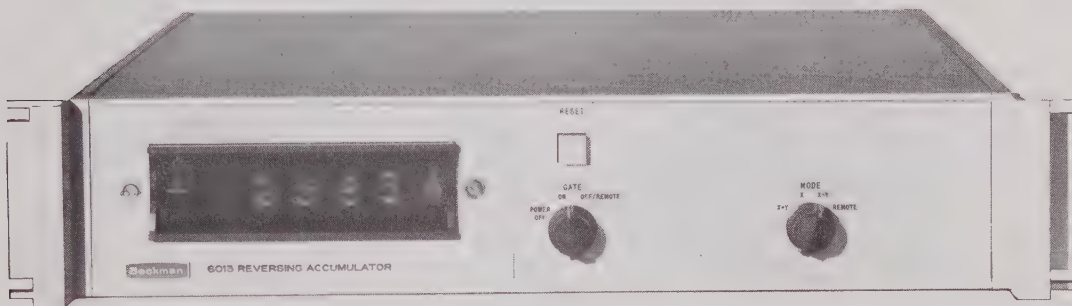


Fig. 2-1. Model 6013 Front Panel

2.2 APPLYING POWER

The instrument is ready to use as it arrives from the factory. To energize the instrument, plug the power cord into a 117 vac, 50 to 60 cycle source. Turn the GATE switch to ON or OFF/REMOTE, thus energizing all circuits in the instrument.

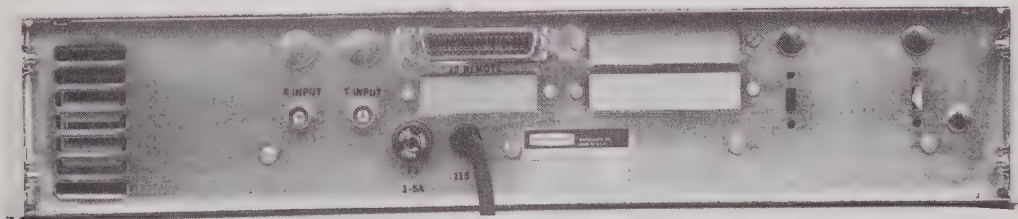


Fig. 2-2. Rear Panel Connectors

2.3 MODES OF ACCUMULATION

The modes of accumulation are selected with the MODE selector on the front panel. The mode of accumulation associated with each position is listed in Table 2-1.

Table 2-1. Modes of Accumulation

Mode	Operation
X + Y	Inputs X and Y are both added positively to the accumulated sum at a maximum rate of 2,000,000 bits per second. At least $0.5\ \mu\text{s}$ separation is required between inputs.
X - Y	Input X is algebraically added while input Y is algebraically subtracted to the accumulated sum at a maximum rate of 2,000,000 bits per second. At least $0.5\ \mu\text{s}$ separation is required between successive inputs.
X (Sense)	Input Y is disabled. Data on input X can be algebraically added to or subtracted from the accumulated sum at a maximum rate of 2,000,000 bits per second. Direction of count (positive or negative sense) is controlled on the remote connector. At least $1\ \mu\text{s}$ must intervene between any sense change and the preceding bit of input data.
Remote	Mode of accumulation is selected by grounding the proper pin(s) on the remote connector. a) X+Y Mode: Ground Pin 16. b) X Mode: Ground Pin 17. c) X - Y Mode: Ground Pin 18.

2.3.1 Anticoincidence Option

As described in Table 2-1, minimum separation between successive inputs on X and Y is $0.5\ \mu\text{s}$.

With the anticoincidence option, simultaneous input events on X and Y can be counted. The anticoincidence circuits provide approximately 450 nanosecond separation between simultaneous inputs, thus eliminating the restriction of $0.5\ \mu\text{s}$ separation.

2.4 EXTERNAL CONTROLS AND CONNECTORS

Most operating controls are located on the front panel as shown in Figure 2-1. X and Y INPUT connectors, BCD data output connector and remote connector are located on the rear panel as shown in Figure 2-2.

Table 2-2 explains each control on the front panel. Table 2-3 explains the function of each rear panel connector.

Table 2-2. Front Panel Controls (Model 6013)

GATE Switch	In ON or OFF/REMOTE, all circuits in the instrument are energized. ON: Count gate is open and the instrument accumulates X and Y inputs according to the selected mode. OFF/REMOTE: Gate control is transferred to the remote connector. With pin 33 grounded, count gate is open. With pin 33 open circuit, count gate is closed. With the GATE switch in OFF/REMOTE, pin 32 on the remote connector is ground.
MODE Selector	Each position on the MODE selector is explained in Table 2-1.
RESET	At any instant of time, the accumulator can be reset to zero by depressing the RESET button.

Table 2-3. Rear Panel Connectors

X and Y INPUT Connectors J1, J3 (Type BNC)	X and Y input data is applied at these connectors.
REMOTE Connector, J2 (36-Pin Amphenol 57-40360)	Provides remote selection of slope, mode, remote gate control, and remote reset. (Refer to Table 2-4.)

2.4.1 REMOTE Connector (J2)

A 36-pin connector, J2, permits remote gating, mode and slope selection, and reset. In all cases desired gating, reset, and selection requires only a contact closure to ground of the proper pin(s). Table 2-4 shows pin numbering on the remote connector.

Table 2-4. Model 6013 Remote Connector Pin Numbers

Pin Number	Function	Pin Number	Function
1	X - Slope Select	19	Y - Slope Select
2	Ground	20	Ground
3	*	21	*
4	*	22	*
5	*	23	*
6	*	24	*
7	*	25	*
8	*	26	*
9	*	27	*
10	*	28	*
11	*	29	*
12	*	30	*
13	*	31	*
14	*	<u>32</u>	<u>Ground when GATE</u> <u>is OFF/REMOTE</u>
15	Ground when MODE is REMOTE	<u>33</u>	GATE ON
16	X + Y MODE	34	Sense Control
17	X MODE	35	Ground
18	X - Y MODE	36	Remote Reset

*Not used in standard Model 6013

2.5 INTERNAL CONTROLS

2.5.1 Triggering Level Adjustment

The triggering level adjustment and test points are located on the amplifier boards and are accessible from the top of the instrument. There are two test points marked on the board: LEVEL and TEST. Voltage appearing at the LEVEL terminal is the actual triggering level, i.e., value which the input voltage must exceed in order to trigger the input circuit. Voltage appearing at TEST is the actual output from the amplifier.

The adjustment procedure is as follows:

- 1) Connect a voltmeter of at least 1% accuracy to the LEVEL test point and an oscilloscope to the TEST output.
- 2) Connect a signal generator to the amplifier input and set the rms voltage to the desired level using a 100kc signal.
- 3) Using the potentiometer mounted on the amplifier board, adjust the discriminator for maximum sensitivity. This is indicated by the appearance of an output pulse train with approximately 50% duty cycle.
- 4) Continue triggering level adjustment until the output pulse is seen to trigger at the desired instant of time. This is done by shifting the time of occurrence of the leading edge of the output pulse.
- 5) The actual triggering level (plus hysteresis) is indicated by the DC voltmeter. A reading of approximately 0 volts indicates maximum sensitivity.

2.5.2 Slope Selection

The slope control is a contact closure to ground on the remote connector (pin 1 or 19 for X or Y). It determines which slope (positive or negative) of the input signal will trigger an output pulse. Figure 3-3 in Section 3 shows the voltage discriminator output with a sine wave input and the effect of + and - slope switch positions.

Select desired slope as follows:

- 1) For positive (+) slope triggering, pin 1 or 19 (X or Y input, respectively) on the remote connector (J3) must be an open circuit.
- 2) For negative (-) slope triggering the pin must be grounded.

2.5.3 Sense Selection in X MODE

Before operating the instrument in the X (sense) mode, the operator must select the correct sense. A forward (+) sense is defined as going from negative infinity toward positive infinity (+100,000). A reverse (-) sense is defined as going from positive infinity toward negative infinity (-100,000).

Sense control is a contact closure to ground on the remote connector.

To select sense, follow this procedure:

- 1) For forward sense selection, pin 34 on the remote connector must be an open circuit.
- 2) For reverse sense selection, pin 34 on the remote connector must be grounded.

PART A

SECTION 3

THEORY OF OPERATION

3.1 INTRODUCTION

This section describes the basic operating theory of the Model 6013. Information in this section is primarily from a functional approach and minimizes any detailed description of circuit operation.

Logic symbols are defined in the Appendix and are listed along with typical circuits.

3.2 GENERAL OPERATION

The functional boards in the Model 6013 are shown in Figure 3-1. Information from the data source to accessory recorders and readout display is transmitted through the instrument according to the following sequence.

- 1) Data is applied at the inputs to the X and Y amplifiers. The amplifier generates a positive true output which is triggered by the positive or negative slope of the applied signal. Duration of the output is determined by the time the applied signal exceeds the discriminator level. The output is applied to the forward-reverse logic board.
- 2) The forward-reverse logic accepts the X or Y input and generates a signal on either the "forward" output or "reverse" output as determined by the operating mode (and sense, if X MODE), sign of the accumulated sum, and whether or not the accumulated sum is zero. The resulting "forward" or "reverse" signal is applied to the accumulator control board.
- 3) The accumulator control board provides the necessary gating action in the instrument. A signal on the forward or reverse line is either transmitted to the decimal counters or terminated in the control board depending on the state of the count gate (open or closed). The reset generator is also on the accumulator control board.
- 4) The decimal counting units (DCU's) perform the basic addition and subtraction operations and store the accumulated sum. The DCU's have forward and reverse input lines. A signal on the forward line

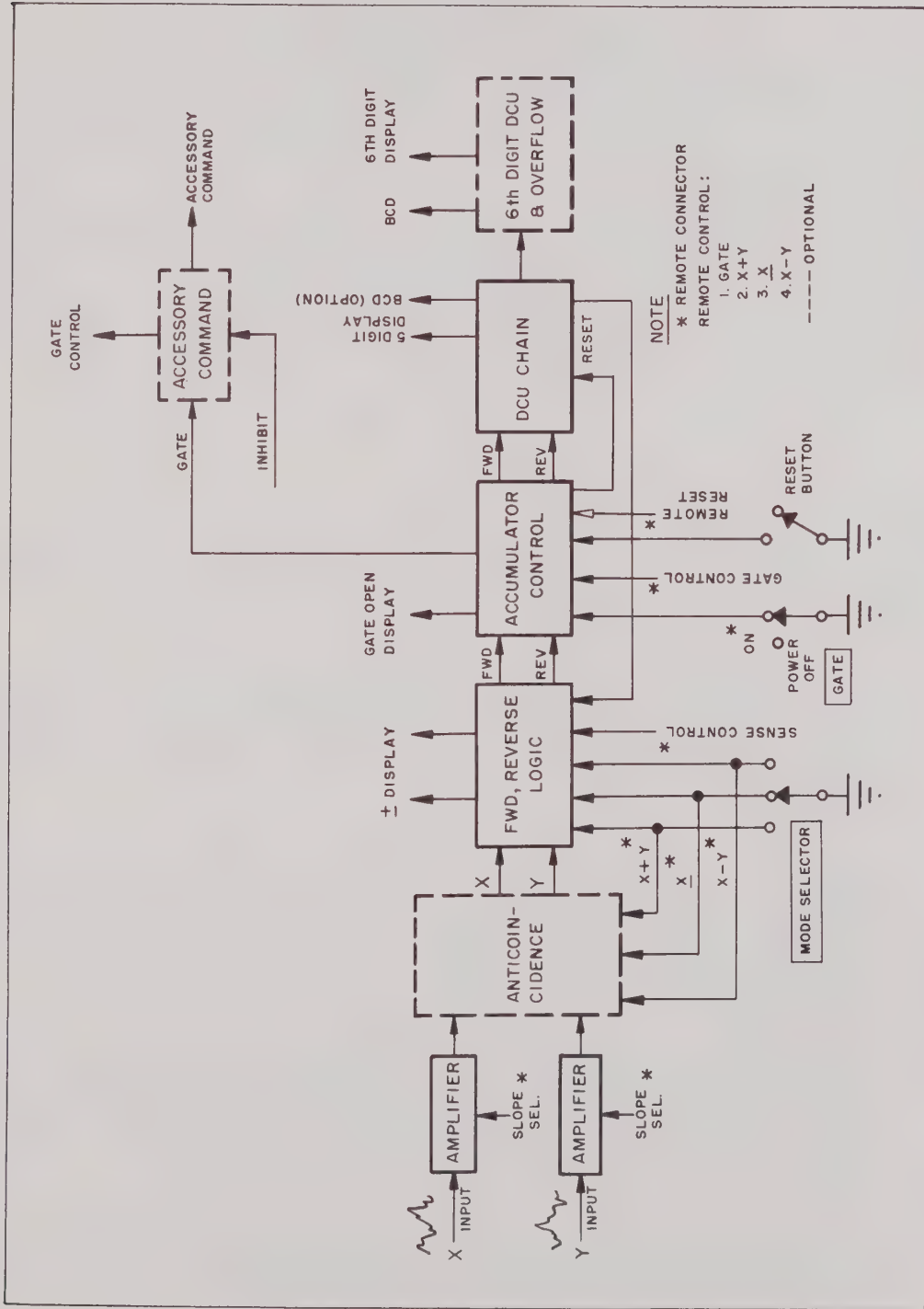


Fig. 3-1. Model 6013 Functional Blocks

increases the absolute value of the accumulated sum, whereas a signal on the reverse line decreases the absolute value of the accumulated sum. The DCU's provide outputs to indicator lamps in the display.

3.3 INPUT AMPLIFIERS

Each input amplifier consists of a discriminator amplifier input circuit followed by slope selection logic.

The discriminator circuit is a differential amplifier using regenerative positive feedback. The use of such feedback and dc switching levels insures the fast switching time which is essential in high frequency applications.

The slope selection logic permits triggering on either the positive or negative slopes of the input signal. An input to the discriminator circuit generates a 0.8 volt p-p positive true signal to the slope selection circuits and appears at the amplifier output as a positive true pulse (-7 volts to ground). If a positive slope is selected, the output is triggered by the leading edge of the discriminator output, whereas if a negative slope is selected, the output is triggered by the trailing edge. Figure 3-2 shows the slope selection logic. Figure 3-3 shows the result of amplifier discrimination and slope selection.

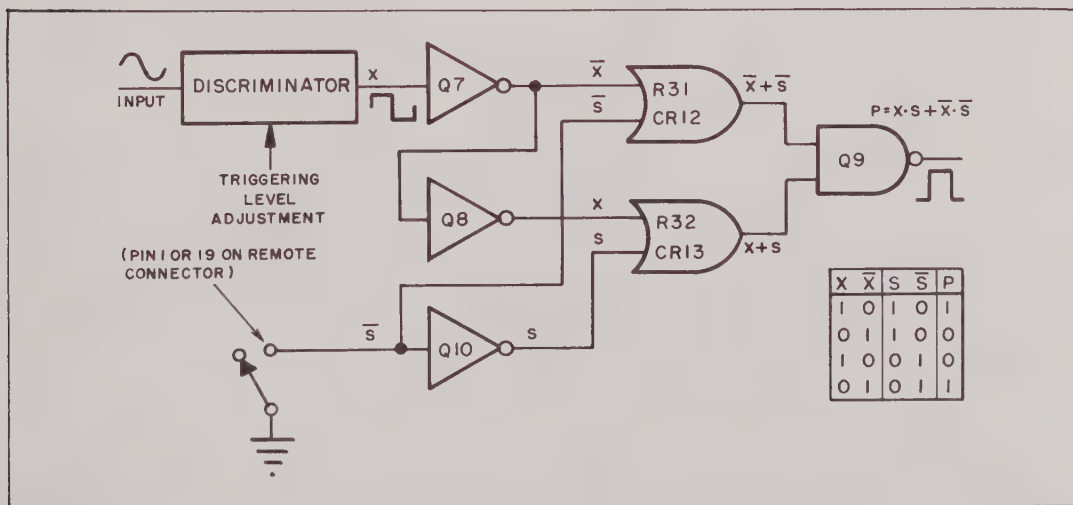


Fig. 3-2. Slope Selection Logic Diagram

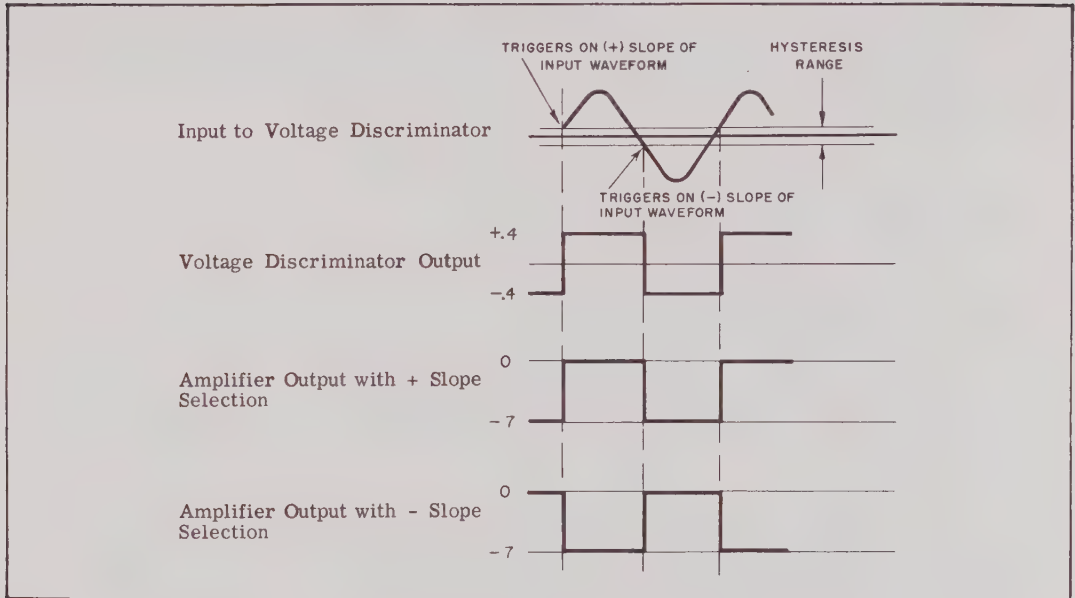


Fig. 3-3. Amplifier Input and Output Signals

3.4 FORWARD AND REVERSE LOGIC BOARD

3.4.1 General

The Forward-Reverse logic couples inputs from the two amplifiers to the control unit and decimal counting units. This is accomplished according to the mode of operation desired and the sign of the accumulated sum.

The forward-reverse logic provides two input lines to the control unit, one for FORWARD and the other for REVERSE operation of the DCU chain. Transmission of signals appearing on these lines to the DCU chain is controlled by the gating action of the control unit. The transmission of a signal on the FORWARD line causes an increase in the absolute value of the accumulated sum, whereas the transmission of a signal appearing on the REVERSE line causes a decrease in the absolute value of the accumulated sum.

3.4.2 Sign Indication

Logic for the sign indication is shown in Figure 3-4. The outputs from a flip-flop (Q8 and Q9) are used to indicate + or - sign. Application of "set" and "clear" pulses result in POSITIVE and NEGATIVE sign indications, respectively.

As shown in Figure 3-4, a "set" pulse is produced only when a pulse from amplifier X (X_p) occurs, and only when the AND gate is open. To operate the AND gate, either of the following conditions must be satisfied:

- 1) All inputs to the OR gate (CR33, 34, 35) are logic "0", that is:
 - a) $\overline{\text{Zero}} (\bar{Z}) = \text{logic "0"}; \text{ the accumulator displays } \pm 00000.$
 - b) Mode of operation is X.
 - c) Sense is forward.
- 2) All inputs to the OR gate (CR31, 32) are logic "0", that is:
 - a) $\bar{Z} = \text{logic "0"}; \text{ the accumulator displays } \pm 00000.$
 - b) Mode of operation is X - Y.

In either case, the accumulator must register ± 00000 before the flip-flop can be set and display the POSITIVE sign. A "clear" pulse resulting in NEGATIVE sign display is produced with either X_p or Y_p .

- 1) X_p clears the flip-flop when all inputs to the OR gate (CR40, 41, 42) are logic "0".
 - a) $\bar{Z} = \text{logic "0"}; \text{ the accumulator displays } \pm 00000.$
 - b) Mode of operation is X.
 - c) Sense is reverse.
- 2) Y_p clears the flip-flop when all inputs to the OR gate (CR44, 45) are logic "0".
 - a) $\bar{Z} = \text{logic "0"}; \text{ the accumulator displays } \pm 00000.$
 - b) Mode of operation X - Y.

In any case, the sign displayed by the accumulator cannot change if the accumulator contains any numerical information other than zero. Sign changes can occur only when the accumulator registers ± 00000 . Appropriate sign changes according to the preceding discussion are summarized in Table 3-1.

The sign resulting from a RESET signal is POSITIVE in any operating mode.

The empty accumulator assumes the sign of the preceding absolute number. Example: Operating in the X (REVERSE) mode, assume the accumulator contains +00001. An X_p signal will bring the accumulator to "plus" 00000. Had the accumulator contained -00001, the X_p signal would have brought the accumulator to "minus" 00000.

Table 3-1. Forward-Reverse Logic Showing Sign Changes

Mode	Display Before Input	Input	Display After Input
X (Fwd.)	+00000	X_p	+00001
X (Fwd.)	-00000	X_p	+00001
X (Rev.)	+00000	X_p	-00001
X (Rev.)	-00000	X_p	-00001
X - Y	+00000	X_p	+00001
X - Y	+00000	Y_p	-00001
X - Y	-00000	X_p	+00001
X - Y	-00000	Y_p	-00001
X + Y	+00000	X_p	+00001
X + Y	+00000	Y_p	+00001

3.4.3 Forward-Reverse Operation

The remainder of the "forward-reverse" logic board provides the "accumulate forward" (FWD.) and "accumulate in reverse" (REV.) commands to the decimal counting units through the intermediate accumulator control unit. The logic diagram for this operation is shown in Figure 3-5.

Outputs from this part of the circuit board depend on the mode of operation (and sense, when operating in the X mode), the sign of the accumulated sum, and the state of the DCU chain (either ZERO or $\overline{\text{ZERO}}$).

The commands "accumulate forward" or "accumulate in reverse" (FWD or REV) are triggered by pulses from either amplifier X or Y. The respective FWD and REV control signals for each amplifier are designated X_F , X_R , Y_F , and Y_R (Figure 3-5). Thus, X_p can trigger a FWD command only if X_F is "TRUE" to maintain the proper AND gate in the open state. For Y_p to trigger the FWD command, Y_F must be TRUE in order to maintain the proper AND gate in the open state. Likewise, X_R and Y_R must be TRUE to maintain their respective AND gates open thus enabling the amplifier signals to produce a REV command.

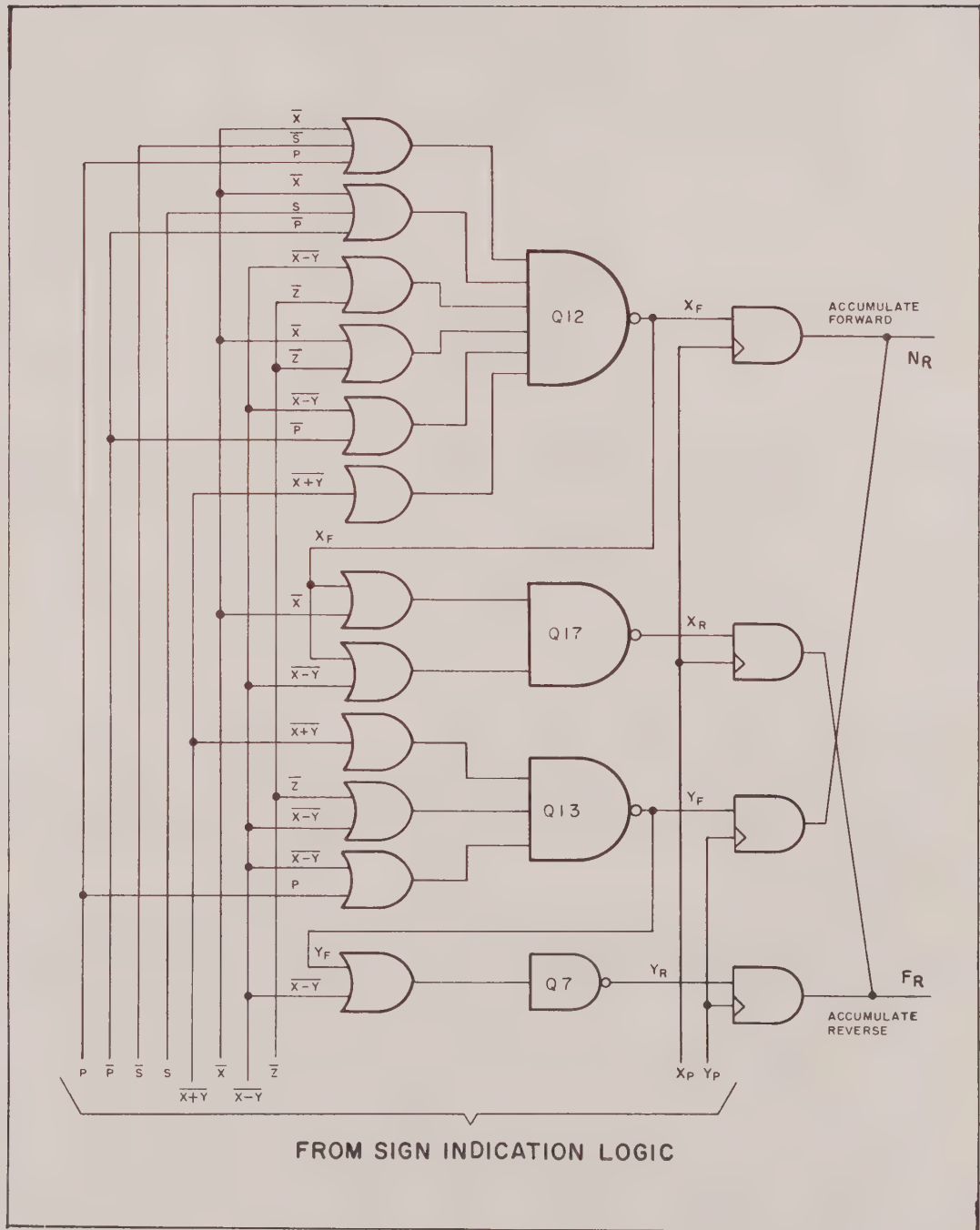


Fig. 3-5. Forward-Reverse Logic of F-R Logic Board

Conditions for the four FWD-REV control signals to be TRUE are as follows:

- 1) X_F TRUE: Q12 must be turned ON, that is, at least one of the six inputs to Q12 must be FALSE. This requires all inputs to at least one of the six OR gates to be FALSE. Written symbolically:

$$X_F = \overset{(a)}{\underline{X - Y}} \cdot P + \overset{(b)}{\underline{X + Y}} + \overset{(c)}{\underline{X}} \cdot S \cdot \overline{P} + \overset{(d)}{\underline{X}} \cdot \overline{S} \cdot P + \overset{(e)}{\underline{X - Y}} \cdot Z + \overset{(f)}{\underline{X}} \cdot Z$$

Therefore, any of the following six conditions will result in X_F TRUE:

- a) $X - Y$ mode when sign is (+).
- b) $X + Y$ mode.

NOTE

Operation in the $X + Y$ mode should never result in a (-) sign. This precludes changeover to the $X + Y$ mode at a time when the sign is already (-). Doing this will result in incorrect accumulation, since negative numbers will automatically be converted to positive numbers. For most purposes, this is an undesirable operation and could result in incorrect information unless the operator is aware of what has occurred.

- c) X mode in (-) sense when the sign is (-).
 - d) X mode in (+) sense when the sign is (+).
 - e) $X - Y$ mode when the accumulator is "empty".
 - f) X mode when the accumulator is "empty".
- 2) X_R TRUE: Q17 must be turned ON, that is, at least one of the inputs to Q17 must be FALSE. This requires all inputs to either of the two OR gates to be FALSE (this requires X_F to be FALSE). Written symbolically:

$$X_R = (X \cdot \overline{X_F}) + (X - Y \cdot \overline{X_F}) \quad \text{where}$$

$$\overline{X_F} = \overline{(\underline{X + Y})} \cdot (\overline{X} + \overline{S} + P) \cdot (\overline{X} + S + \overline{P}) \cdot (\overline{X - Y} + \overline{Z}) \cdot (\overline{X} + \overline{Z}) \cdot (\overline{X - Y} + \overline{P})$$

Therefore, X_R TRUE results only when operating in either $X - Y$ or $\overline{X}$ modes and under specific conditions related to operation in each mode. The following three conditions will result in X_R TRUE:

- a) X mode in (+) sense, when sign is (-), accumulator is not empty.
 - b) X mode in (-) sense when sign is (+), accumulator is not empty.
 - c) X - Y mode, when sign is (-). accumulator is not empty.
- 3) Y_F TRUE: Q13 must be turned ON, that is, at least one of the three inputs to Q13 must be FALSE, requiring all inputs to at least one of the three OR gates to be FALSE. Symbolically:

$$Y_F = \overset{(a)}{\underline{(X+Y)}} + \overset{(b)}{\underline{(X-Y \cdot Z)}} + \overset{(c)}{\underline{(X-Y \cdot \bar{P})}}$$

Therefore, any of the following three conditions will result in Y_F TRUE:

- a) X + Y mode.
 - b) X - Y mode and accumulator is empty.
 - c) X - Y mode and sign is (-).
- 4) Y_R TRUE: Q7 must be turned ON, requiring both inputs to the OR gate to be FALSE. Symbolically:

$$Y_R = \underline{(X-Y)} \cdot \bar{Y}_F = \underline{(X-Y)} \cdot (\underline{\overline{(X+Y)}}) \cdot (\underline{\overline{(X-Y+Z)}}) \cdot (\underline{\overline{(X-Y+P)}})$$

Therefore, Y_R TRUE can only occur when operation is in the X - Y mode, accumulator is not empty and sign is (+).

Table 3-2 summarizes steps (1) through (4). The table shows the resulting direction command when pulses are received from amplifiers X or Y under all possible input conditions.

3.4.4 Example of Accumulator Operation

Assuming the FWD-REV command signals to be ungated by the accumulator control unit, the accumulation process proceeds according to the operation outlined in Tables 3-1 and 3-2. Figure 3-6 illustrates the accumulation process for the X - Y mode.

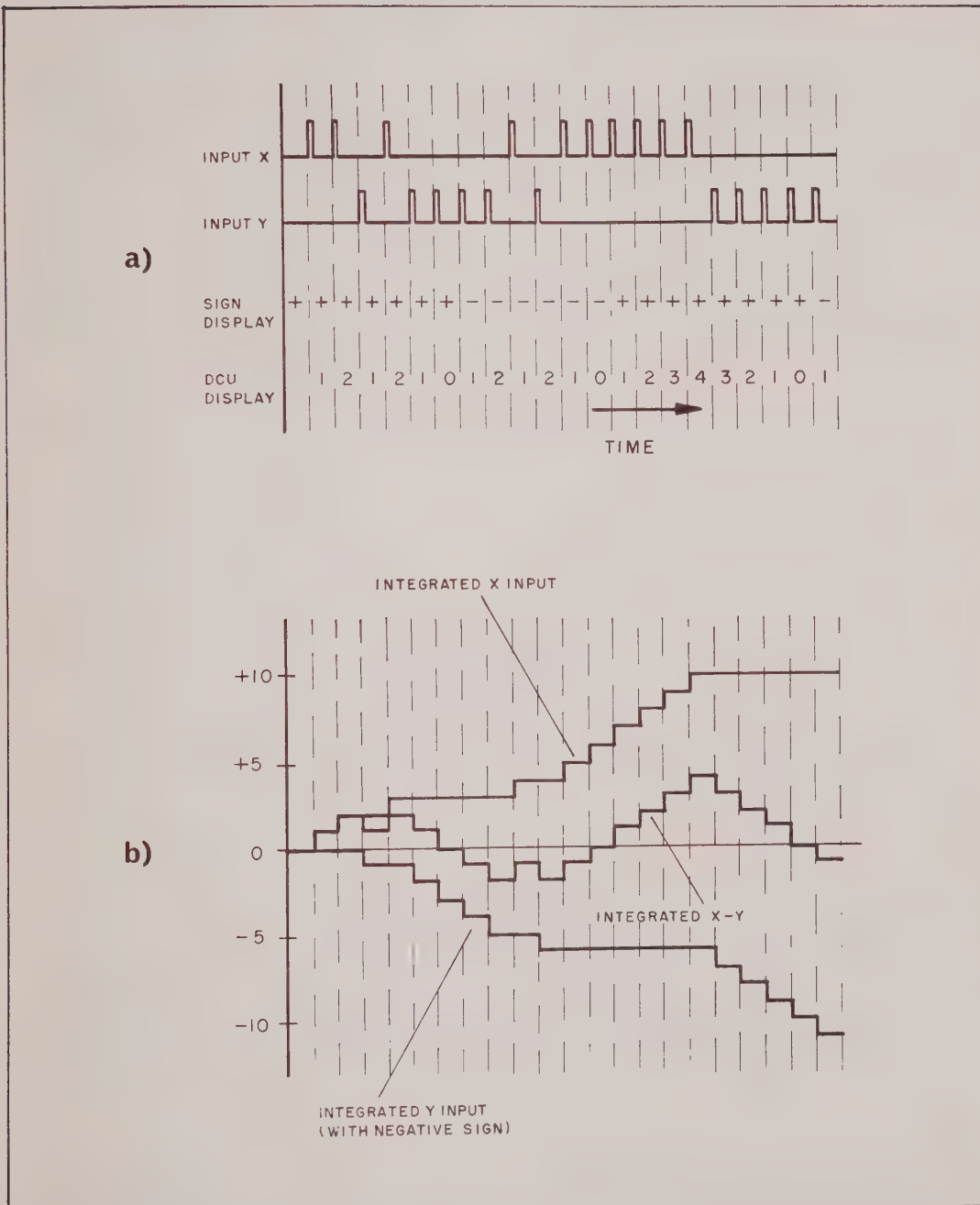


Fig. 3-6. Example of Accumulator Operation in X - Y Mode
a) Sign and Numerical Display.
b) Numerical Integration of X - Y.

Table 3-2. Forward-Reverse Operation

Mode	Sense	$\overline{\text{Zero}}$	Sign	Input (X)	Input (Y)
X + Y	$\pm$	1 or 0	+**	FWD	FWD
X - Y	$\pm$	0	+	FWD	FWD
	$\pm$	0	-	FWD	FWD
	$\pm$	1	+	FWD	REV
	$\pm$	1	-	REV	FWD
$\underline{\text{X}}$	-	0	-	FWD	*
	+	0	+	FWD	*
	-	0	+	FWD	*
	+	0	-	FWD	*
	+	1	-	REV	*
	-	1	+	REV	*
	+	1	+	FWD	*
	-	1	-	FWD	*

* No output on either FWD or REV lines.

**Theoretically, operation in the X + Y mode never results in a (-) sign. See note under step (1) of paragraph 3.4.3.

3.5 ACCUMULATOR CONTROL BOARD

3.5.1 General

A logic diagram for the accumulator control board is shown in Figure 3-7. The board contains two circuits: a reset generator circuit, and a count gate circuit.

3.5.2 Reset Generator

Reset is a contact closure to ground which triggers a 200 nanosecond positive-true pulse to all DCU's. It also triggers a 200 nanosecond negative-true reset pulse to all flip-flops. The reset pulse for the DCU's appears at the emitter of Q7 (pin R_F), while the reset pulse for the flip-flops appears at the emitter of Q5 (pin N_F).

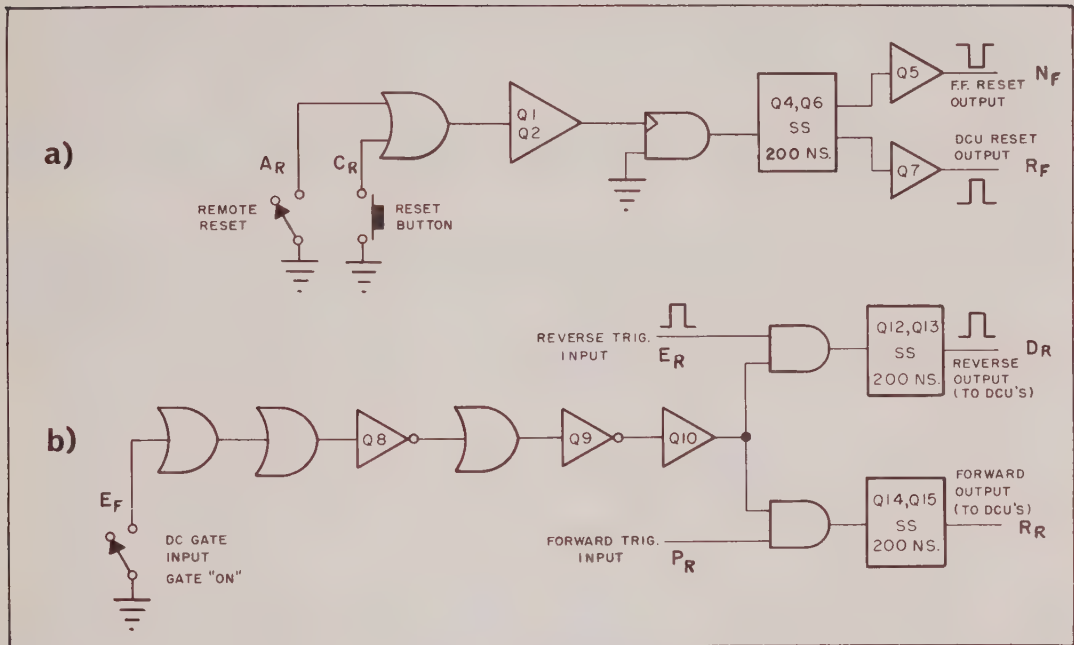


Fig. 3-7. Accumulator Control Board Logic Diagram
a) Reset Generator Logic
b) Count Gate Logic

3.5.3 Count Gate

The front-panel GATE switch in the ON position grounds pin E_F (logic "1") and causes the AND gate to the forward and reverse single-shots to open. A forward or reverse pulse from the forward-reverse logic board is able to then activate an output single-shot, producing a positive true (-6 volts to ground) 200 nanosecond pulse to the decimal counting units. A reverse count appears at the collector of Q12 (pin D_R). A forward count appears at the collector Q14 (pin R_R).

3.6 DECIMAL COUNTING UNITS (DCU's)

The basic counting circuits in the instrument consist of a chain of five decimal counting units connected in tandem. Each DCU provides outputs to the display and can provide BCD outputs to external recorders (option). The five DCU's provide the zero coincidence signal to the

forward-reverse logic board when all of the DCU's register zero. (In the Models 6014 and 6015 Preset Accumulator, each DCU also provides a signal to the preset switches.)

Since each DCU generates one output pulse for every ten input pulses, the bank of five DCU's performs as a decimal counter with an absolute capacity of 99,999.

The DCU's used in the 601X series accumulators have the ability to accumulate in either the forward direction (add) or reverse direction (subtract). If a pulse on the FWD input line is received, the DCU chain increases absolutely by a value of one; if a pulse on the REV input line is received, it decreases absolutely by a value of one.

3.6.1 DCU Technical Characteristics

Table 3-3 lists the technical characteristics of the DCU.

Table 3-3. Technical Characteristics of the DCU

Input Requirements	Positive-going pulse or voltage step, 5-7 volts p-p, less than 20 ns rise time; pulse duration at least 150 ns, from a low impedance source (180 ohms or less at 0 volt input).
Counting Rate	0-2 Mc in forward or reverse direction; requires at least 0.5 μ s between successive input pulses.
Output	Binary coded decimal outputs (option). The DCU provides lamp drive (0-9), zero coincidence, available outputs to preset switches; (not used in the Model 6013).

3.6.2 DCU Operation

The DCU divides by 10 in two steps: division by two, then division by five. This type of division requires a binary stage followed by a quinary stage. Therefore, the actual "count" is represented by the states of seven transistors. The bi-quinary decimal code is shown in Table 3-4. The logic voltage levels have been reversed in the bi-quinary as noted in the table. A DCU logic diagram is shown in Figure 3-8. Logic "1" output in the figure corresponds to logic "0" in Table 3-4, and vice versa.

Table 3-4. Bi-Quinary Decimal Code

Binary			Quinary				
Decimal	Q ₁	Q ₂	Q ₇	Q ₈	Q ₉	Q ₁₀	Q ₁₁
0	1	0	1	0	0	0	0
1	0	1	1	0	0	0	0
2	1	0	0	1	0	0	0
3	0	1	0	1	0	0	0
4	1	0	0	0	1	0	0
5	0	1	0	0	1	0	0
6	1	0	0	0	0	1	0
7	0	1	0	0	0	1	0
8	1	0	0	0	0	0	1
9	0	1	0	0	0	0	1
Logic "1" (or TRUE) refers to transistor being in OFF state. Logic "0" (or FALSE) refers to transistor being in ON state.							

The binary section alternates between 0 and 1, and changes the state of the quinary once with the acceptance of every two incoming counts. The quinary provides an output to the next DCU in the chain and returns to its original state after every five counts are received from the binary.

The binary changes state when either a FWD or REV count is received, whereas the quinaries change states either progressively in the "forward" direction or "reverse" direction.

Progressive change in the forward direction occurs when there is an increase in magnitude from an odd number to an even number. This is reflected in the circuitry when a higher order transistor turns OFF. For example, assume the DCU displays a decimal "3". Then all quinary transistors would be ON except for Q₈. Progressing forward to decimal "4" requires all quinary transistors to be ON except for the next higher order transistor, Q₉. For a progressive change in the forward direction to occur, the circuit requires that Q₂ is OFF and that a FWD count is received. If only the latter occurs, and Q₂ is ON, the quinary does not change.

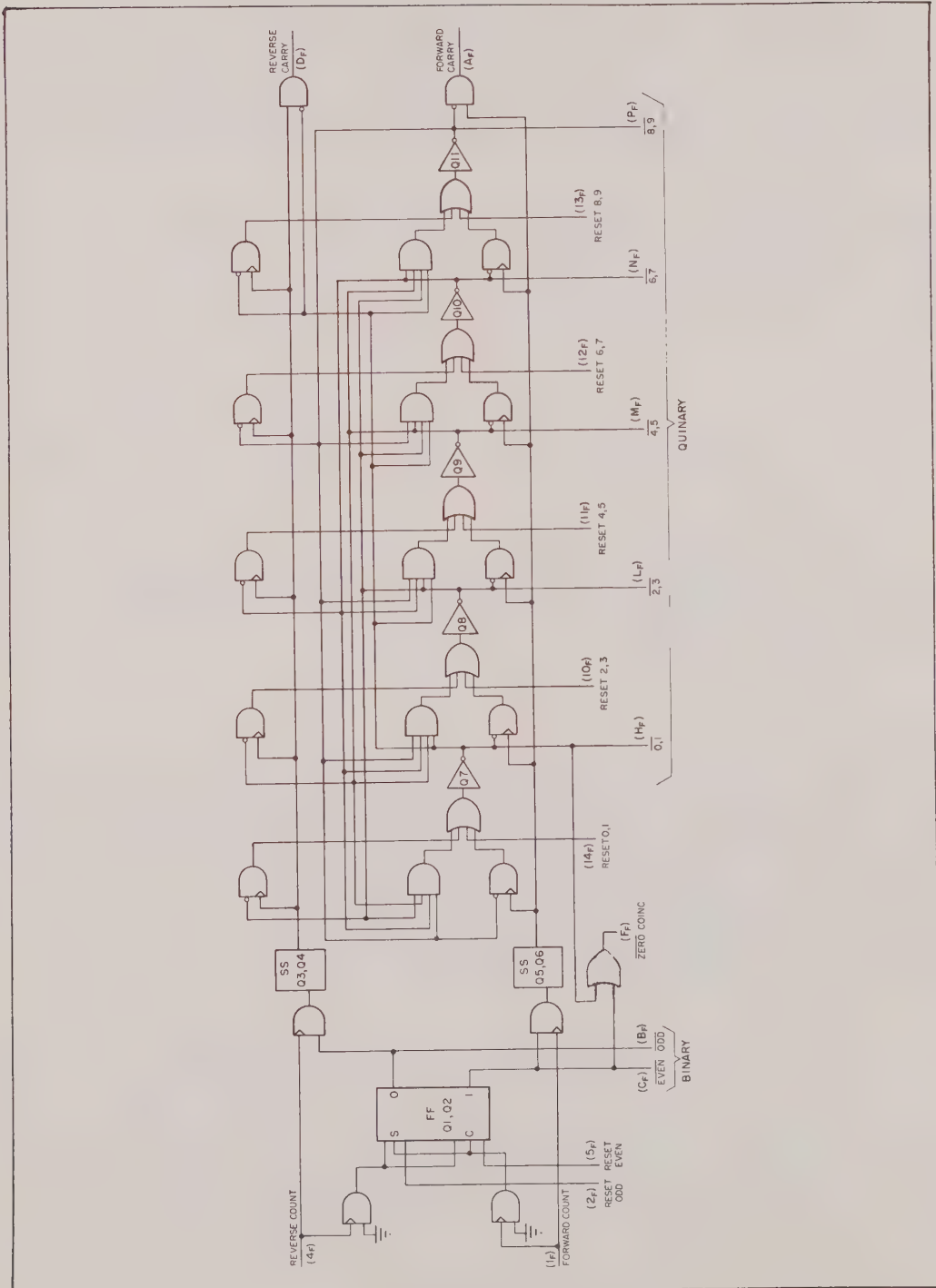


Fig. 3-8. Forward-Reverse Decimal Counting Unit Logic Diagram

Progressive change in the reverse direction occurs when there is a decrease in magnitude from an even number to an odd number. This is reflected in the circuitry when the OFF transistor progresses in the reverse direction.

Going forward from 9 to 0 results in a forward count applied to the next higher order DCU and the bi-quinary resets to decimal zero. Going in reverse from 0 to 9 results in a reverse count applied to the next higher order DCU and resets the bi-quinary to decimal '9'. The logic diagram for the basic forward and reverse operation is shown in Figure 3-8.

The five quinary outputs together with the EVEN and ODD lines are combined to provide outputs to lamp drives. The outputs from Q1 and Q7 enter an AND gate to provide the DCU zero coincidence indication.

3.6.3 Lamp Drives

Since the ODD and EVEN outputs are the "common" lines on the lamp blocks, they determine which of the two possible decimal digits are present on the quinary output lines. A typical lamp block - DCU interconnection diagram, is shown in Figure 3-9.

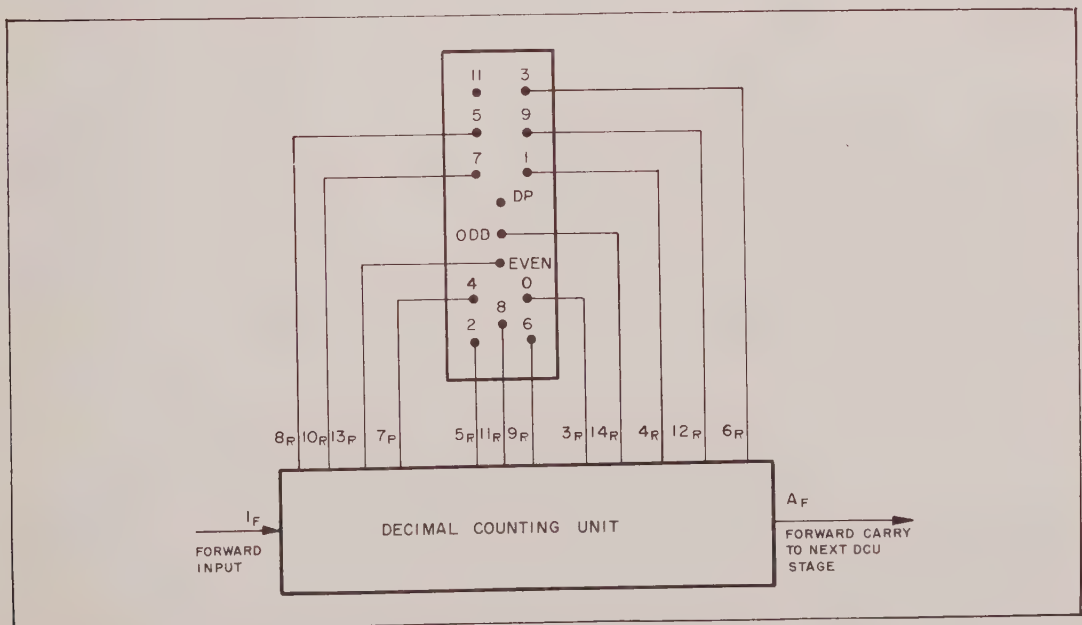


Fig. 3-9. Lamp Block - DCU Interconnection

3.6.4 BCD Outputs (Option)

Outputs from the "count" transistors can be combined to provide BCD outputs to a recorder. Four output lines are used for all codes and changing from one code to another requires a reassignment of weights to each line, and changes in the output circuit.

PART A

SECTION 4 SERVICING

4.1 GENERAL

This section provides adjustment procedures and troubleshooting information for the 6000 Series Accumulators.

4.1.1 Required Test Equipment

Table 4-1 lists the test instruments required for servicing the accumulator.

Table 4-1. Recommended Test Equipment

Instrument	Specifications
Oscilloscope	50 mc bandwidth, 3.5 nanosecond rise-time.
Signal Generator	1 cps to 100 kc, 1 volt rms output.
Signal Generator	100 kc to 2 mc, 1 volt rms output.
Volt-Ohmmeter	100,000 ohms/v dc.
Auto Transformer	0 - 130 volts ac, 60 cps.

4.1.2 Printed Circuit Board Identification

Table 4-2 lists the printed circuit boards used in the 6000 Series Accumulators.

Table 4-2. Printed Circuit Boards Used in 6000 Series Accumulators

P. C. Board Detail No.	Description	Model					
		6003	6004	6005	6013	6014	6015
XA 103-203	10^5 FWD/REV DCU	x	x	x	x	x	x
XA 104-204	10^4 FWD/REV DCU	x	x	x	x	x	x
XA 105-205	10^3 FWD/REV DCU	x	x	x	x	x	x
XA 106-206	10^2 FWD/REV DCU	x	x	x	x	x	x
XA 107-207	10^1 FWD/REV DCU	x	x	x	x	x	x
XA 108-208	10^0 FWD/REV DCU	x	x	x	x	x	x
XA 109-209	Accum. Control	x	x	x	x	x	x
XA 110-210	FWD/REV Logic				x	x	x
XA 114	Preset N ₁		x	x		x	x
XA 115	Preset N ₂			x			x
XA 214	X Amplifier	x	x	x	x	x	x
XA 215	Y Amplifier				x	x	x

4.1.3 Component Location

Use the drawing on the inside top cover of the instrument to locate assemblies and components which are mounted on the main chassis. Components on printed circuit boards may be located using the layout drawings furnished in the manual.

4.1.4 Extension Boards

Two extension boards are supplied with the instrument to provide easy access to components and test points on printed circuit boards during operation.

4.2 ADJUSTMENTS

4.2.1 Power Supply Adjustments

The regulated power supply adjustments are located on Regulator Board A1 (Figure 4-1).

Power supply test points are located on the bottom of the chassis along a horizontal terminal strip (Figure 4-2). Wires from the three terminals are color coded as follows: RED +15V, GREEN -15V, YELLOW -32V.

4.2.1.1 Adjustment Procedure

CAUTION

Do not remove the Regulator Board (A1) from its receptacle without first unplugging the AC line cord from its power source.

- 1) Use a voltmeter of at least 1% accuracy. Voltage measurements are referenced to chassis ground.
- 2) Use Figure 4-2 to locate power supply test points.

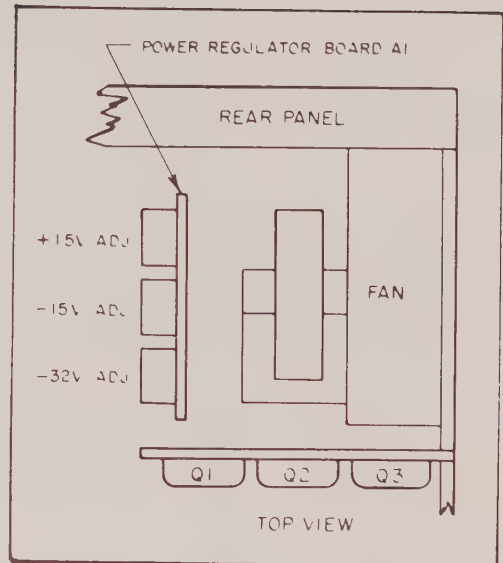


Fig. 4-1. Location of Power Supply Adjustment

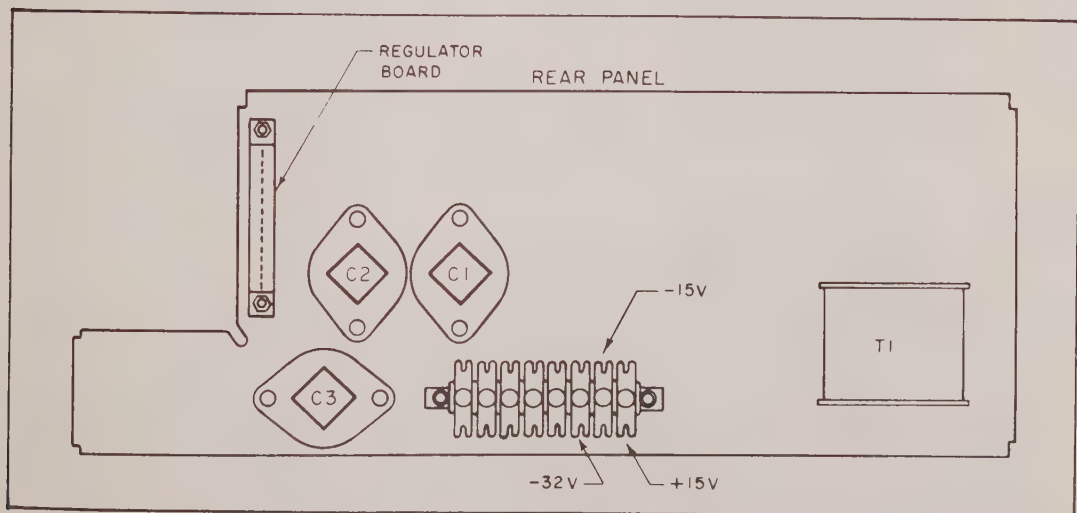


Fig. 4-2. Location of Power Supply Test Points

- 3) Adjust -15 V ADJ to -15 volts, ± 0.2 volt.
- 4) Adjust -15 V ADJ to -15 volts, ± 0.2 volt.
- 5) Adjust -32 V ADJ to approximately -29.5 volts.

4.2.2 Triggering Level Adjustment

The trigger level adjustment and test points are on the amplifier boards and are accessible from the top of the instrument. There are two test points marked on the board: LEVEL and TEST. Voltage appearing at the LEVEL terminal is the actual triggering level, or value which the input voltage must exceed in order to trigger the input circuit. Voltage appearing at TEST is the actual output from the amplifier. Maximum sensitivity occurs when the level is near zero volts.

4.2.2.1 Adjustment Procedure

- 1) Connect voltmeter of at least 1% accuracy to LEVEL and OSCILLOSCOPE to TEST.
- 2) Connect signal generator to amplifier input. Using a 100kc signal, set the rms voltage to the desired level.
- 3) Using the potentiometer mounted on the amplifier board, adjust the discriminator for desired sensitivity. Maximum sensitivity is indicated by the appearance of an output pulse train with approximately 50% duty cycle.
- 4) Actual triggering level (plus hysteresis) is indicated by the dc voltmeter; a reading of approximately 0 volts indicates maximum sensitivity.

4.3 TROUBLESHOOTING

4.3.1 General

Most circuits in the Model 6000 Series Accumulators are mounted on printed circuit boards which can be removed and replaced easily. Troubleshooting can be greatly simplified by replacing boards suspected of being faulty with spare boards which are known to be in good working order. Once the faulty board is found, it can be repaired and returned to operation.

4.3.2 Replacing Components on Printed Circuit Boards

To prevent damage to the printed circuit board and its components, use heat sparingly and work carefully. Follow this procedure for removing a defective component.

- 1) Melt the solder in the component lead holes and tap the board gently to remove solder around component leads.
- 2) Straighten component leads with long-nose pliers or soldering aid.
- 3) Remove the defective component.
- 4) If component cannot be removed, reheat leads slightly.

To install a new component:

- 1) Clean lead holes thoroughly.
- 2) Cut and bend component leads to proper length and shape.
- 3) Insert leads into holes and solder into place.

NOTE

When installing transistors or diodes, use a heat sink to prevent excessive heat conduction through the component. Long-nose pliers applied between the component and the soldering iron make an effective heat sink.

4.3.3 Over-All Troubleshooting

Troubles can often be isolated to an individual circuit board by observing front panel indications in the various operating modes.

When the faulty board has been located, some of the idealized waveforms and voltage levels given in Section 3 may be helpful in locating the exact problem.

PART B

SECTION 1

INTRODUCTION

1.1 GENERAL

The Models 6014 and 6015 are basic Model 6013 type accumulators with the addition of preset capability. Model 6014 provides single preset capability, whereas Model 6015 provides dual preset capability.

The basic forward-reverse accumulation process is performed exactly the same as in the Model 6013. All circuit boards present in the Model 6013 are present in Models 6014 and 6015. The Model 6014 has a single preset board and 5-digit preset select switch added to the Model 6013 circuits and controls. The Model 6015 has two preset boards and two 5-digit preset select switches added to the Model 6013 circuits and controls.

The preset accumulators are basic forward-reverse accumulators which perform a specific function when the accumulator reaches a preset number. The three possible functions are basically as follows:

- 1) Reset accumulator to zero when the accumulator reaches the preset sum, (RESET N).
- 2) Inhibit further counting when the preset sum is reached; store and display the preset sum indefinitely, (HOLD N).
- 3) Generate an electrical output when the preset sum is reached; continue uninterrupted counting to 99,999, reset to zero and continue counting, (N LIMIT).

1.2 SPECIFICATIONS

Specifications are the same as for the Model 6013. Counting rate in RESET N function is dc to 1.7 mc.

1.3 OPTIONS

Options for the Models 6014 and 6015 are listed in Table 1-2, Part A, Section 1.

PART B

SECTION 2

OPERATION

2.1 GENERAL

Models 6014 and 6015 have the same inputs and front panel controls as the Model 6013. The Model 6014 has an additional output line on which an output signal is generated when the preset limit is reached. Model 6015 has two additional output lines on which output signals are generated when the respective preset limits are reached.

Both instruments have additional controls on the front panel which permit selection of sign of the preset number and the function to be performed when the accumulator reaches the preset number.

The following information regarding operation of the Model 6013 is also applicable to both Models 6014 and 6015.

- 1) Applying Power (Section 2-2).
- 2) Modes of Accumulation; Table 2-1, MODE Selector; Anticoincidence option (Section 2-3).
- 3) Rear Panel Connectors (Table 2-3).
- 4) Internal Controls (Section 2-5).

2.2 EXTERNAL CONTROLS AND CONNECTORS

Most operating controls are located on the front panel as shown in Figure 2-1 (Model 6014), or Figure 2-2 (Model 6015). X and Y input



Fig. 2-1. Model 6014 Front Panel

- Operation -

connectors, BCD data output connection (option), and remote connector are located on the rear panel exactly as in the Model 6013 (shown in Figure 2-2 of Model 6013 manual).

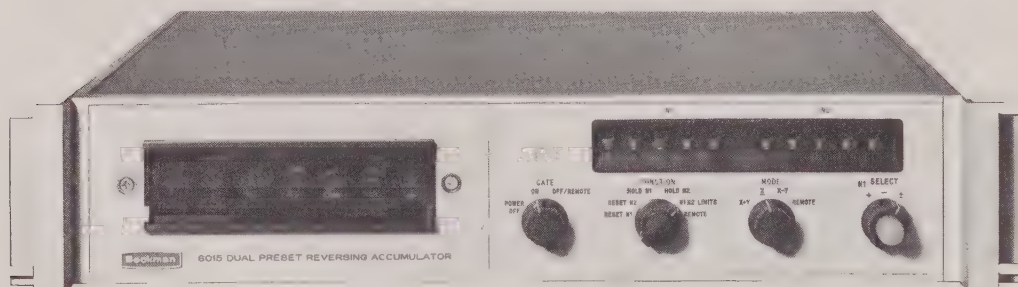


Fig. 2-2. Model 6015 Front Panel

Table 2-1 explains each control on the front panel. Table 2-2 explains the function of each rear panel connector.

Table 2-1. Front Panel Controls (Models 6014, 6015)

Name	Function
GATE Switch	In ON or OFF/REMOTE, all circuits in the instrument are energized. ON: Count gate is open and the instrument accumulates the X and Y inputs according to the selected mode. OFF/REMOTE: Gate control is transferred to the remote connector. With Pin 33 grounded, count gate is open. With Pin 33 open circuit, count gate is closed. With the GATE switch in OFF/REMOTE, Pin 32 on the remote connector is ground.
MODE Selector	Each position on the MODE selector is exactly the same as for the Model 6013. Refer to Table 2-1 of the 6013 manual.

continued. . .

Table 2-1. Front Panel Controls (Models 6014, 6015) - continued

Name	Function
Preset Switches Model 6014: Model 6015:	A single set of 10-digit thumbwheel switches permits selection of a single pre-set number. Two sets of 10-digit thumbwheel switches permit selection of two preset numbers, N_1 and N_2.
N SELECT Switch Model 6014: Model 6015:	A single three-position rotary switch permits selecting the sign of the preset number. In the $\pm$ position, the instrument performs the selected function when the <u>absolute value</u> of the accumulated sum reaches the <u>absolute value</u> of the preset number. A concentric three-position rotary switch permits independent selection of the signs of the two preset numbers. The $\pm$ position is as defined above for the Model 6014. The black inner switch selects the sign of N_1 while the white outer switch selects the sign of N_2.
FUNCTION Selector Model 6014:	This is a four-position rotary switch. When the accumulated sum reaches the preset number the following functions are performed: a) RESET N: Resets to zero and continues to accumulate; accumulation is uninterrupted. An electrical signal having 150 ns duration is generated at instant of reset. Signal appears on Pin 7 of the remote connector. b) HOLD N: Accumulator stops counting. The preset sum is stored and displayed until instrument is reset.

continued. . .

Table 2-1. Front Panel Controls (Models 6014, 6015) - continued

Name	Function
FUNCTION Selector Model 6014 - cont.	c) N LIMIT: An electrical step output appears on Pin 7 of remote connector. The level remains until the instrument either is reset or again reaches the preset number while accumulating in the opposite sense. Accumulation is uninterrupted. d) REMOTE: Function is selected with contact closures to ground on the remote connector. Pin 9 on remote connector becomes ground. 1) RESET N - Ground Pin 11. 2) HOLD N - Ground Pin 10. 3) N LIMIT - Both Pins 10 and 11 are kept open.
Model 6015:	The FUNCTION selector is a six-position rotary switch. When the accumulated sum reaches a preset number, the following functions are performed: a) RESET N_1: When accumulated sum reaches N_1, the instrument resets to zero and continues to accumulate, uninterrupted. At instant of reset, an electrical signal having 150 ns duration is generated. Signal appears on Pin 7 of remote connector. b) RESET N_2: The above function is performed when the accumulated sum reaches N_2. The output signal appears on Pin 6 of the remote connector. c) HOLD N_1: When accumulated sum reaches N_1 accumulator stops counting. The preset sum is stored and displayed until instrument is reset. d) HOLD N_2: The above function is performed when the accumulated sum reaches N_2.

continued. . .

Table 2-1. Front Panel Controls (Models 6014, 6015) - continued

Name	Function
FUNCTION Selector Model 6015 - cont.	e) N_1 N_2 LIMITS: Electrical step outputs are generated when accumulator reaches N_1 and N_2. These levels remain until the instrument is reset or again reaches the preset numbers while accumulating in the opposite sense. The N_1 level appears on Pin 7 while the N_2 output level appears on Pin 6 of the remote connector. f) REMOTE: Function is selected with contact closures to ground on the remote connector. Pin 9 on remote connector becomes ground. 1) RESET N_1: Ground Pin 11. 2) RESET N_2: Ground Pin 13. 3) HOLD N_1: Ground Pin 10. 4) HOLD N_2: Ground Pin 12. 5) N_1 N_2 LIMITS: Pins 10, 11, 12, and 13 are kept open.

Table 2-2. Rear Panel Connectors

X and Y INPUT J1, J3 (Type BNC)	X and Y data is applied at these connectors.
Remote Connector J2 (36-Pin Amphenol 57-40360)	Provides remote selection of slope, FUNCTION, MODE, remote control and reset. Also provides N preset outputs (refer to Table 2-3).

2.3 REMOTE CONNECTOR J2

The REMOTE connector permits remote gating and reset, and selection of slope, function, and mode. In all cases, desired gating, reset, and selection requires only a contact closure to ground of the proper pin(s). The preset N output signal(s) also appear at the remote connector. Table 2-3 shows pin numbering on the remote connector.

Table 2-3. Models 6014 and 6015 Remote Connector Pin Numbers

Pin Number	Function	Pin Number	Function
1	X - slope select	19	Y - slope select
2	Ground	20	Ground
3	*	21	*
4	*	22	*
5	*	23	*
6	(N ₂ output)	24	Ground - twisted with 6
7	N ₁ output	25	Ground - twisted with 7
8	*	26	*
9	Ground when FUNCTION is REMOTE	27	*
10	HOLD N ₁ FUNCTION	28	*
11	RESET N ₁ FUNCTION	29	*
12	(HOLD N ₂ FUNCTION)	30	*
13	(RESET N ₂ FUNCTION)	31	*
14	*	32	Ground when GATE is OFF/REMOTE
15	Ground when MODE is REMOTE	33	GATE ON
16	X MODE	34	Sense Control
17	X + Y MODE	35	Ground
18	X - Y MODE	36	Remote Reset
* Not used in standard instrument.			
() Not used in Model 6014.			

2.4 OPERATING PROCEDURE

- 1) To turn the instrument on, set GATE switch to either ON or OFF/REMOTE.
 - a) ON: Count gate is OPEN. Instrument accumulates data appearing at X and Y inputs.
 - b) OFF/REMOTE: GATE control is transferred to the remote connector. Providing Pin 33 on remote connector is not grounded, count gate is CLOSED.
- 2) Select individual positive or negative X and Y input slope triggering. Follow procedure outlined in Section 2.5.2 of Model 6013 manual.
- 3) Adjust individual X and Y input triggering levels. Follow procedure outlined in Section 2.5.1 of Model 6013 manual.
- 4) Select desired operating mode with MODE selector. If operating in X MODE, select the sense using procedure outlined in Section 2.5.3 of Model 6013 manual. If operating in REMOTE MODE, follow procedure outlined in Table 2-1 of Model 6013 manual under the REMOTE mode.
- 5) Select each digit of the preset number(s).
- 6) Select sign(s) of the preset number(s) with the N SELECT.
- 7) Set FUNCTION selector to the desired function. If operating in REMOTE, select function according to procedure outlined in Table 2-1 under FUNCTION selector; REMOTE.
- 8) When ready to accumulate, press RESET button. If remote reset is used, ground Pin 36 on remote connector.

PART B

SECTION 3

THEORY OF OPERATION

3.1 GENERAL

All operational boards present in the Model 6013 are present in the Models 6014 and 6015. These boards are located in the same positions as in the Model 6013. In addition, the Model 6014 has a single "preset" circuit board while the Model 6015 has two "preset" circuit boards.

3.2 THEORY OF OPERATION OF THE BASIC REVERSING ACCUMULATOR

The "basic reversing accumulator" section of the Models 6014 and 6015 (input amplifier, forward-reverse logic, accumulator control, and decimal counting units) is the same as for the Model 6013. Theory of Operation is described in Sections 3.1 through 3.6 of the Model 6013 manual. Block diagrams of the printed circuit boards present in the Models 6014 and 6015 are shown in Figure 3-1, a fold-out sheet at the end of this section.

3.3 PRESET BOARDS

3.3.1 General

The preset boards are used with the Models 6014 and 6015 Accumulators. The purpose of this board is to provide either a dc gate or reset trigger signal to the accumulator control whenever the accumulated sum reaches the preset limit. These signals correspond to the FUNCTION switch being in either the HOLD or RESET positions. The LIMIT position of the FUNCTION switch results in neither a gate nor reset trigger signal from the preset board. Thus, the operator can have the accumulator stop counting and hold the sum when the preset limit is reached, automatically reset to zero, or count beyond the preset limit.

A diagram of the inputs and outputs to preset board is shown in Figure 3-2. A logic diagram of preset board operation is shown in Figure 3-3.

3.3.2 DCU and Preset Select Switches

The bank of five preset select switches provides a negative-going output pulse (0 to -7 volts) to the preset board whenever the absolute value of the accumulator sum matches the preset number. Each preset switch recognizes the presence of its preset digit in its corresponding DCU by the simultaneous appearance of a signal on the correct dual decimal and odd-even lines. For example, Figure 3-4 shows the 10^1 preset switch at "0". When the 10^1 DCU registers "0", negative-going signals (0 to -6 volts) will appear on H and C. The output diodes in the bank of select switches perform as a negative zone AND gate (refer to Appendix A5). Therefore, an output to the preset board occurs only when all five DCU's simultaneously register their preset decimal digits.

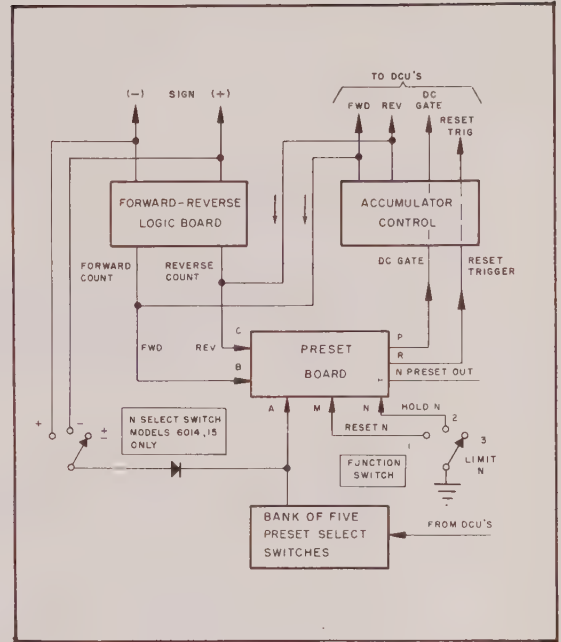


Fig. 3-2. Preset Boards Inputs and Outputs

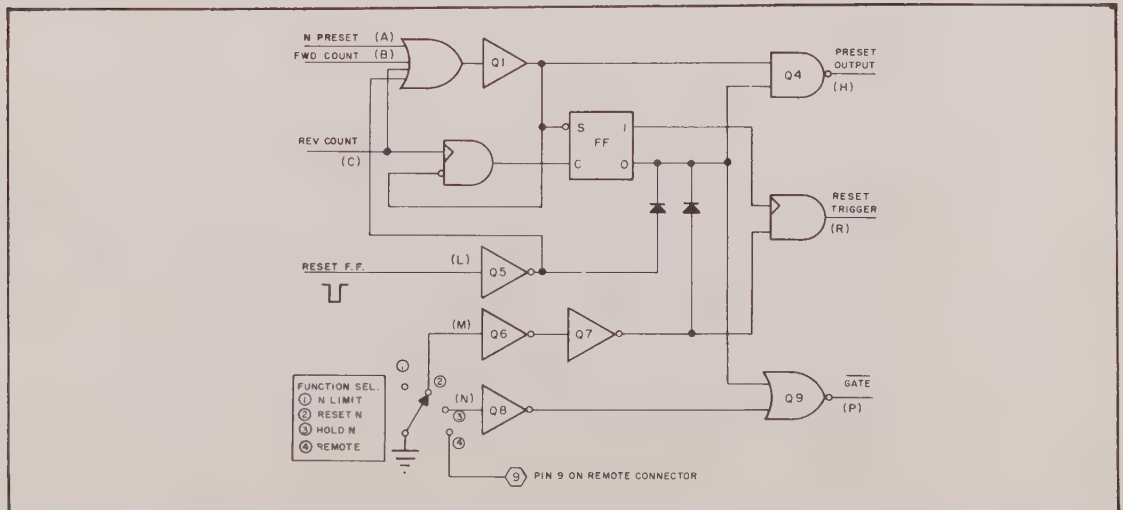


Fig. 3-3. Preset Board Logic Diagram

3.3.3 N-SELECT Switch

The N-SELECT switch selects the sign of the preset number. With the N-SELECT switch and diode connected into the coincidence AND gate as shown (Figure 3-4), the output of the preset switch bank is inhibited whenever the sign appearing in the accumulator is different than the sign of the preset number. Only when the sign of both the N-SELECT and accumulator display are the same will the voltage across the diode be sufficiently negative to ungate the coincidence pulse to the preset board. Therefore, the N-SELECT provides a gate control signal which maintains the coincidence gate "open" only when the signs of both N-SELECT and accumulator display are the same. Any difference in sign will keep the voltage across the diode at ground and the coincidence gate "closed". In the $\pm$ position, the N-SELECT switch relinquishes control of the AND gate, and a coincidence pulse ("magnitude of accumulator sum coincides with preset limit") is generated irrespective of sign.

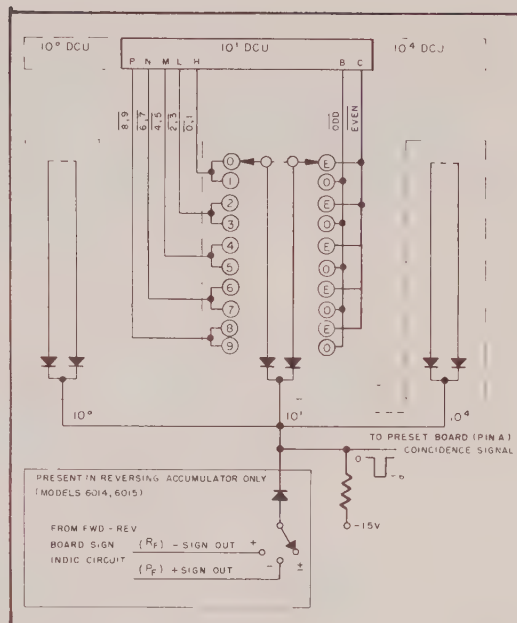


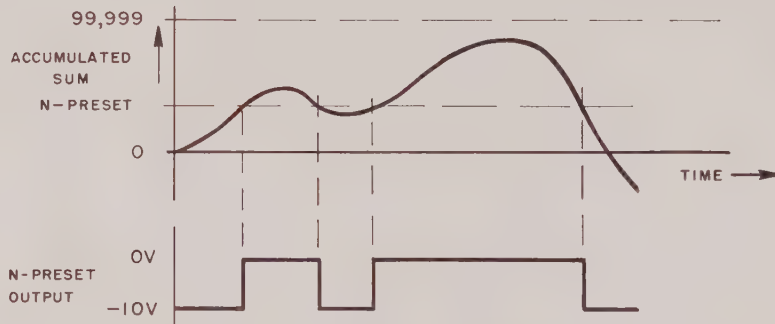
Fig. 3-4. Preset Select Switch Schematic

3.3.4 N-PRESET Out

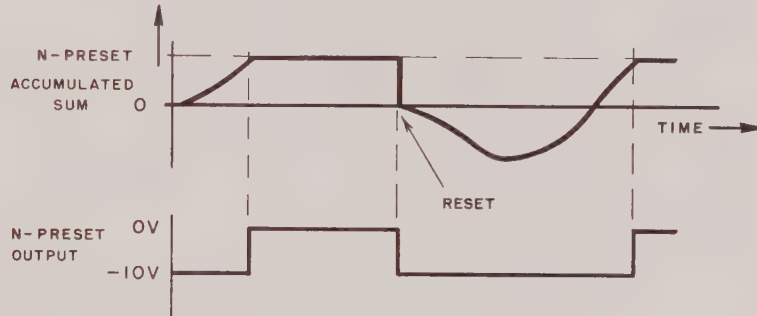
With the FUNCTION switch in the N-LIMIT position, the preset board provides a dc output level (0 volts) whenever the preset limit is exceeded. This dc level remains until the preset limit is again reached with a reverse pulse. It then returns to a negative voltage level (-10 volts) when the accumulator falls below the preset limit (Figure 3-5a).

With the FUNCTION switch in the HOLD-N position, the 0 volt dc level remains until the accumulator is reset to zero (Figure 3-5b).

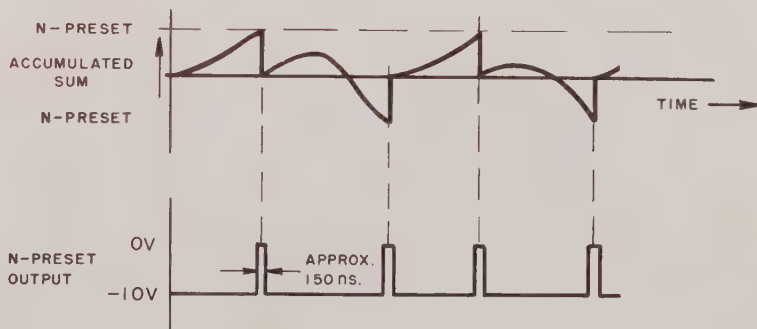
With the FUNCTION switch in the RESET position, the preset board provides a positive-going signal level (-10 volts to ground) each time the accumulator reaches the preset limit. This signal has a duration of approximately 150 nanoseconds (Figure 3-5c).



a) N-PRESET Output When FUNCTION Switch is in N-LIMIT Position. N-SELECT Switch is in + Position.



b) N-PRESET Output When FUNCTION Switch is in HOLD N Position. N-SELECT Switch is in + Position.

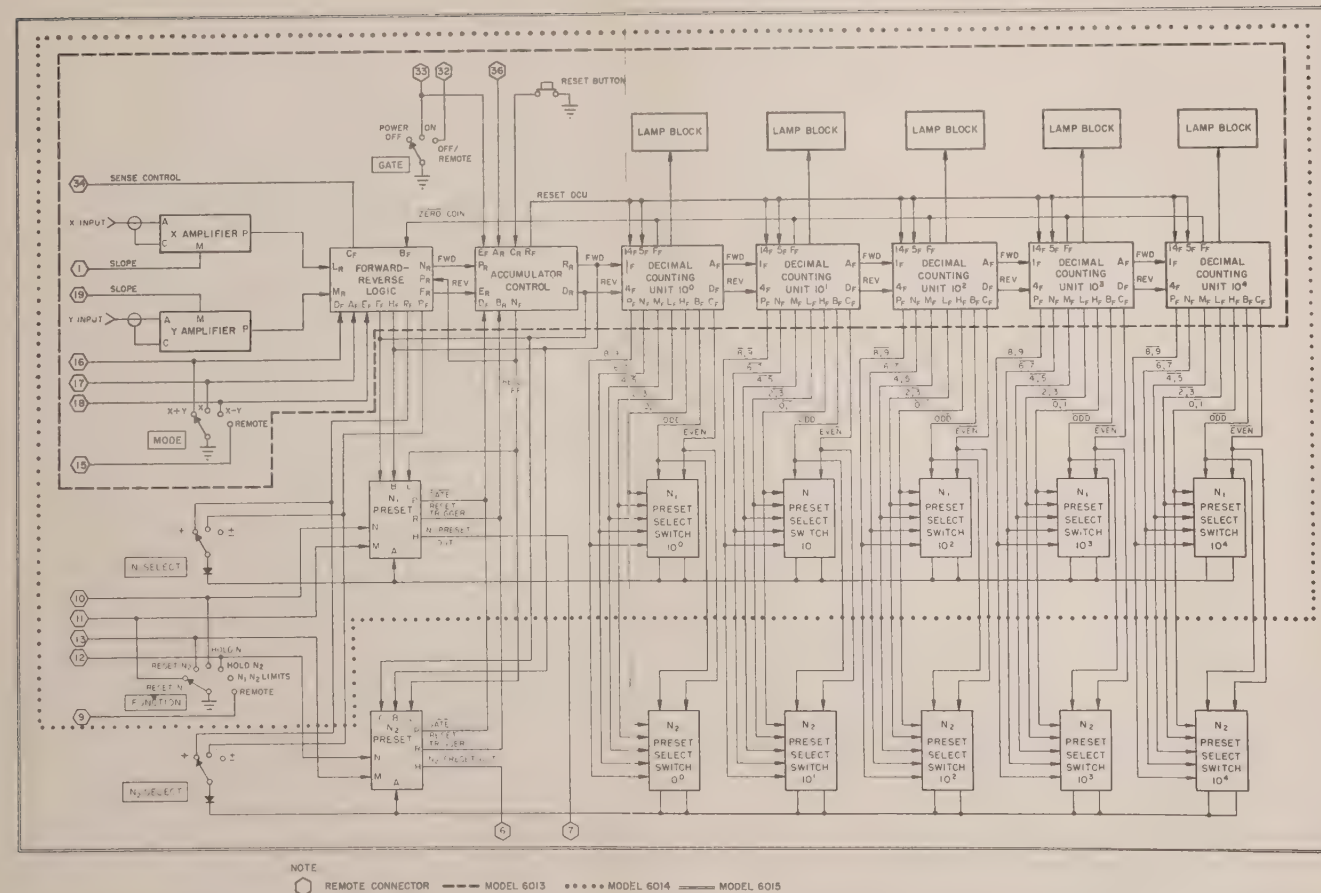


c) N-PRESET Output When FUNCTION Switch is in RESET N Position. N-SELECT Switch is in ± Position.

Fig. 3-5. N-PRESET Outputs

3.3.5 DC Gate and Reset Trigger

The gating signals and reset pulses are triggered with the "0" and "1" outputs from the flip-flop. The gating circuits for these two signals is controlled by the FUNCTION selector being in either the HOLD N or RESET N positions, respectively. As shown in Figure 3-3, the FUNCTION selector controls the NOR or AND output gates for the GATE or "reset trigger" signals in the open condition.



NOTE:
 ○ REMOTE CONNECTOR ——— MODEL 6013 MODEL 6014 ——— MODEL 6015

Fig. 3-1. Block Diagram

PART B

SECTION 4 SERVICING

4.1 GENERAL

Servicing information for the Models 6014 and 6015 is the same as for the Model 6013. Refer to Section 5 of the Model 6013 manual.

MISCELLANEOUS PARTS
Models 6013A, 6014A, 6015A - Outline Drawing)

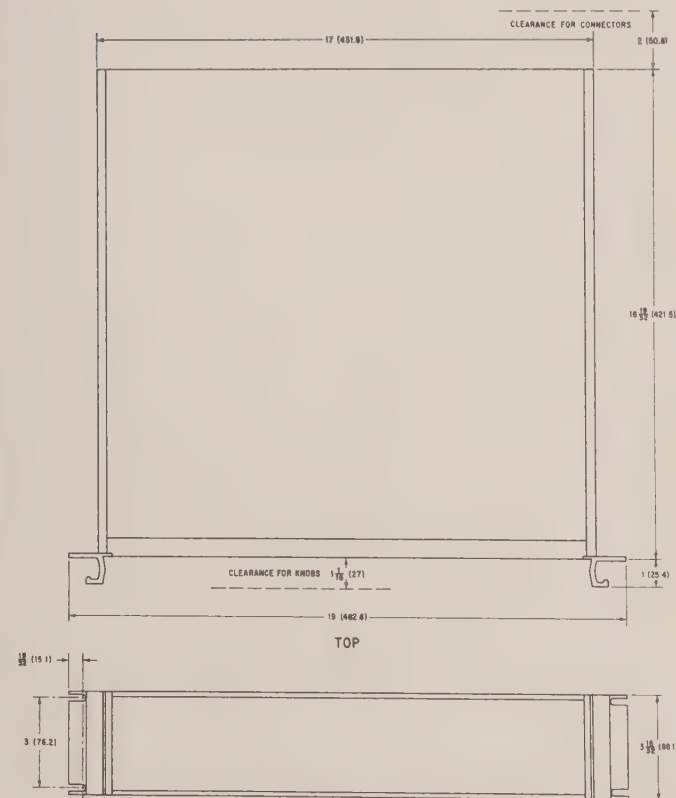
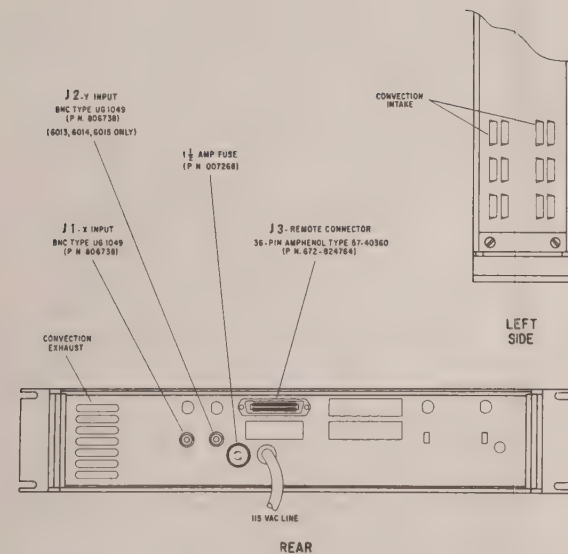
Detail No.	Beckman Part No.	Description	Typical Manufacturer & No.	Qty./ Ass'y
F1	731-801567	Fuse, Elec., 1.5 Amp, 125V, Time Delay	Littelfuse MDL313	1
J1, 2	670-806738	Connector, Coaxial, Receptacle, BNC	Amphenol UG-1094 U	2
J3	672-824764	Connector, Receptacle, 36 pins	Amphenol 57-40360	1
P3	672-824765	Plug, 36 pin	Amphenol 57-30360	1
	680-823481	Connector, P. C., 15 Contacts	Cinch Mfg. 250-15-30-170	4
	680-824115	Connector, P. C., 15 Contacts	Cinch Mfg. 251-15-30-160	10
XF1	735-607268	Fuseholder, 15 Amp at 250V Breakdown	Bussman HKP	1
XDS1	824-813501	Socket, Lamp Cartridge Mtg.	Dialco 7538	1
	824-834669	Lamp, Plug-in	Eldema CF2-CC-1762	1
	711-425471	Switch (Gate)	Beckman	1
	711-425917	Switch (Mode)	Beckman	1
	711-837930	Switch, Thumbwheel, 2-Pole, Bi-Qui	Engineering Electronics A188425A	5
	716-838151	Switch, Pushbutton	Dialco 513-0101-604	1
	716-838152	Lens Cap for Pushbutton Switch, White	Dialco 185-1875	1
	325-420982	Knob, Round, Skirted	Beckman	2
	664-812450	Cordset, Elect., Power, 3 Cond., Blk., 6 ft.	Cornish	1
	662-425863	Cable, Remote	Beckman	1
	885-431044	Resistor Module	Beckman	5
	330-420770	Handle	Beckman	2
	751-841251	Tube, Nixie (p/o Readout Ass'y)	Burroughs B85991	5

MODEL 6014A ONLY

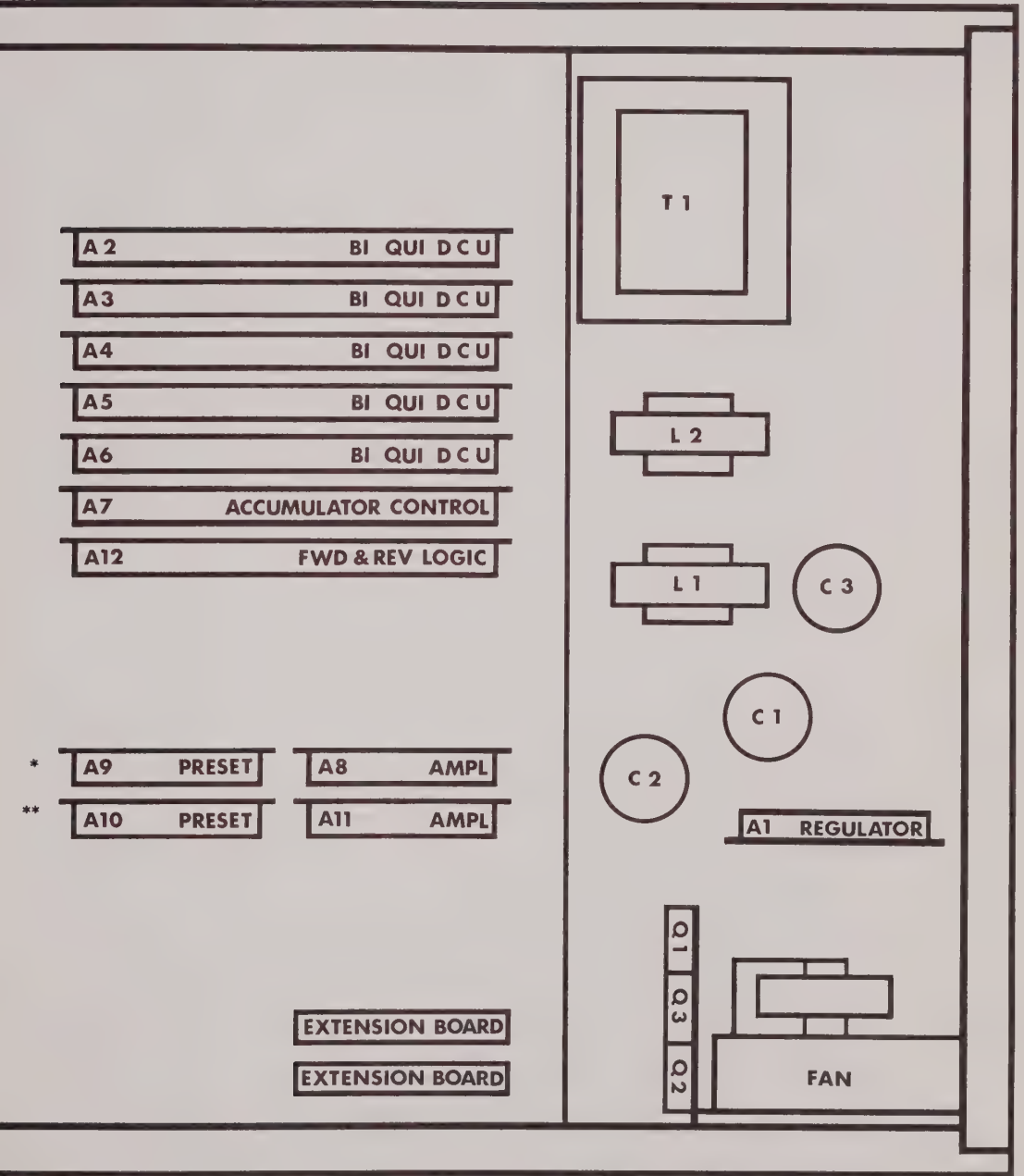
716-838206	Switch, 5 Station	EECO 26S-5	1
680-823481	Connector, P. C., 15 Contacts	Cinch Mfg. 250-15-30-170	5
325-420982	Knob, Round, Skirted	Beckman	4
755-420893	Diode, Germanium	Beckman	11

MODEL 6015A ONLY

711-425919	Switch (Select)	Beckman	1
716-838205	Switch, 11 Station	EECO 26SM-11	1
716-838203	Switch Spacer	EECO S26SM	1
325-415350	Knob, Grey	Beckman	1
325-424471	Knob	Beckman	1
680-823481	Connector, P. C., 15 Contacts	Cinch Mfg. 250-15-30-170	6
711-837930	Switch, Thumbwheel, 2-Pole, Bi-Qui	Engineering Electronics A188425A	10
325-420982	Knob, Round, Skirted	Beckman	3
755-420893	Diode, Germanium	Beckman	22



BOARD LOCATION DIAGRAM



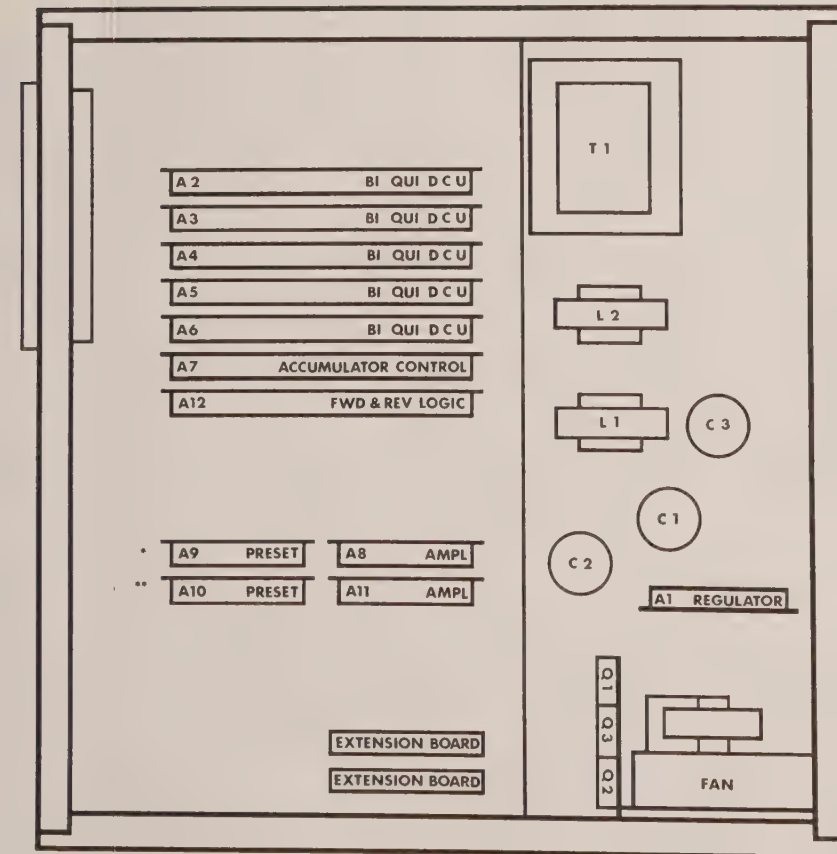
4A and 6015A Only.

A Only.

6013A, 14A, 15A
R427291-Rev. A
April 1967

Beckman

BOARD LOCATION
DIAGRAM

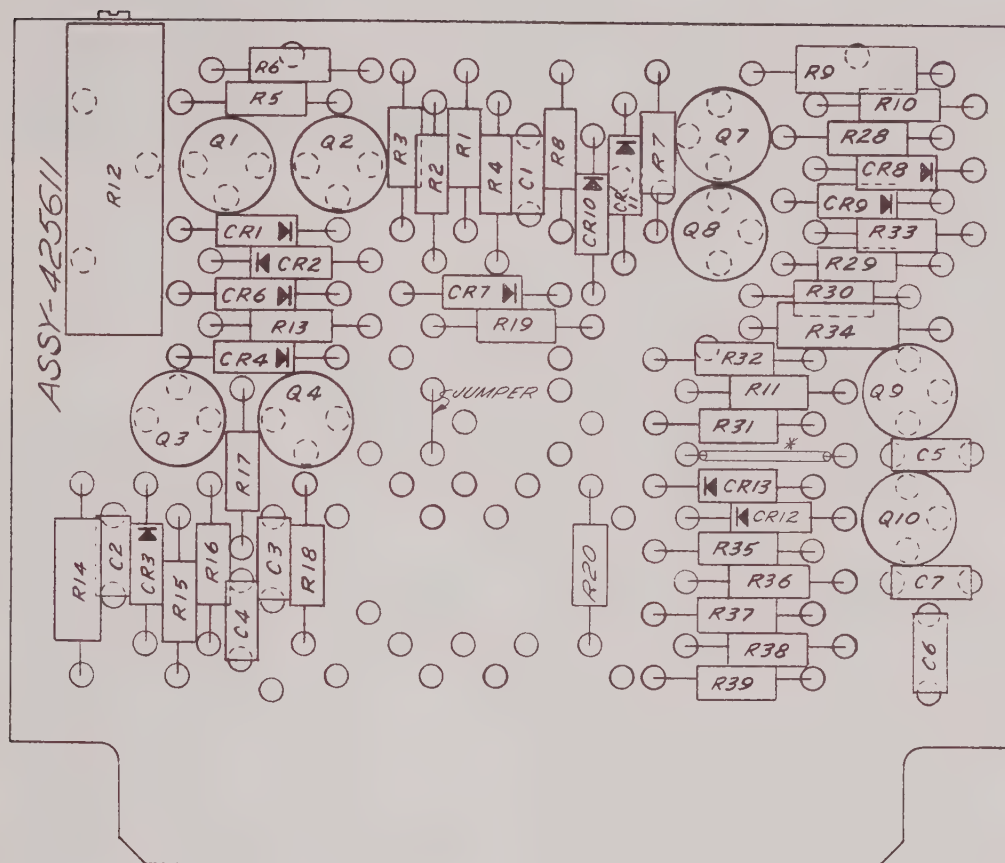


* Models 6014A and 6015A Only.

** Model 6015A Only.

6013A, 14A, 15A
R437501-Rev. A
April 1987

Beckman

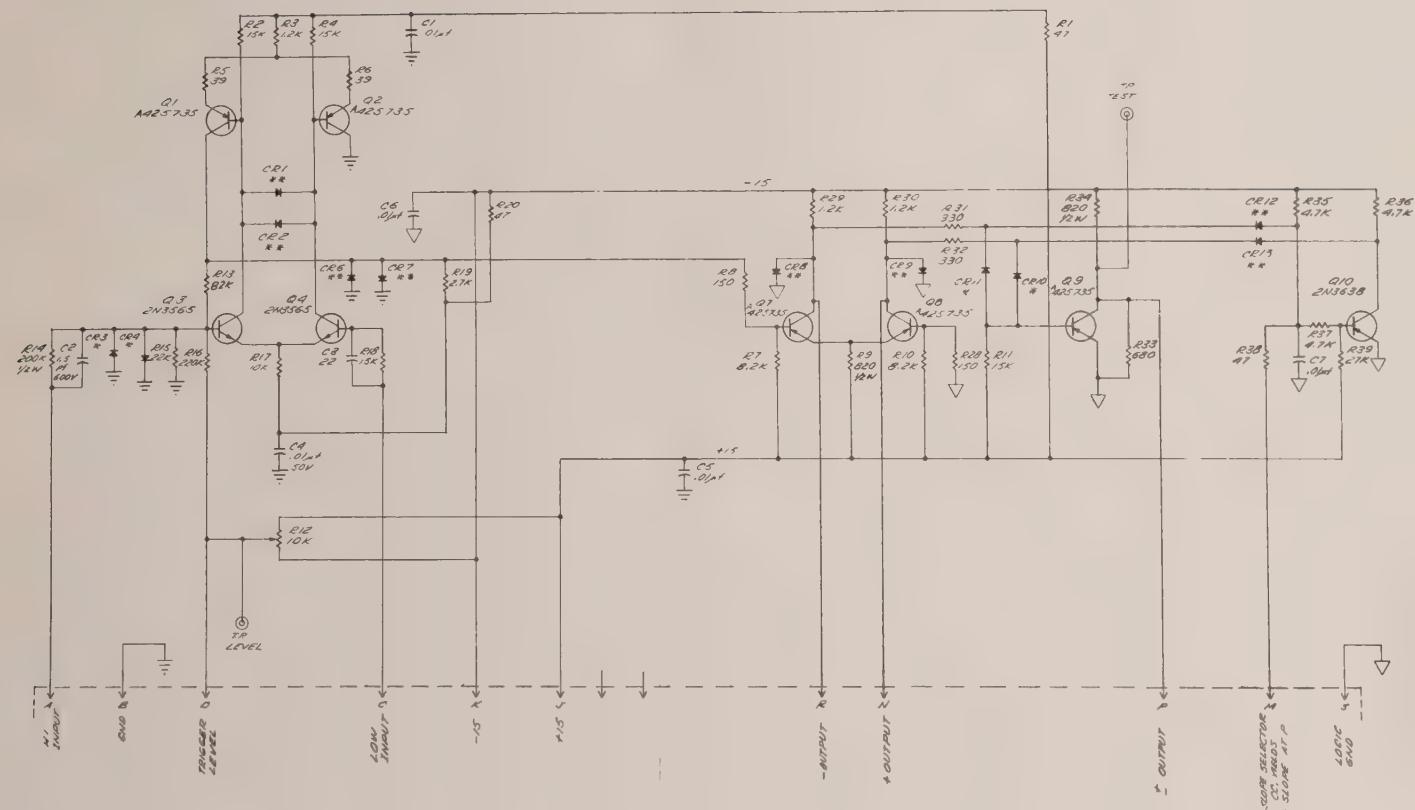


INPUT AMPLIFIER BOARD COMPONENT LAYOUT (A8)

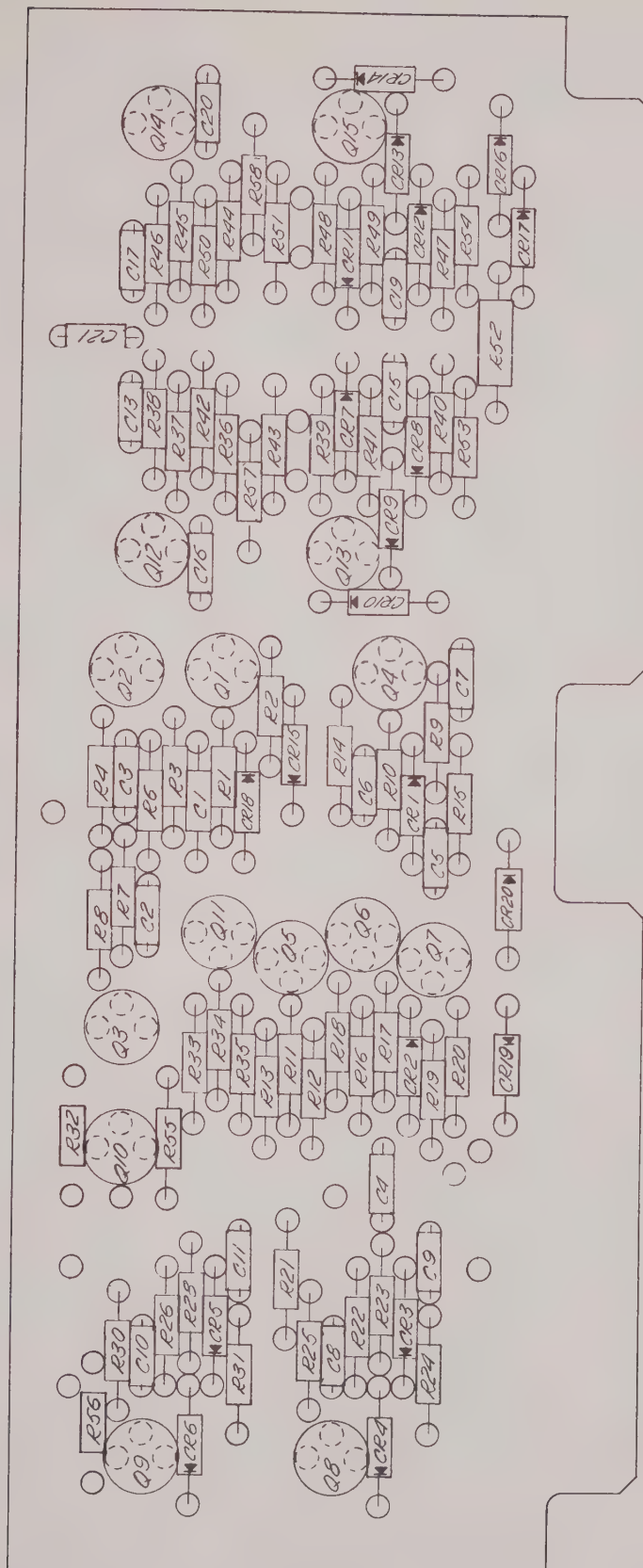
INPUT AMPLIFIER BOARD (A8, A11)
(Models 6013A, 6014A, 6015A)

<u>Detail No.</u>	<u>Beckman Part No.</u>	<u>Description</u>	<u>Typical Manufacturer & No.</u>	<u>Qty./ Assy.</u>
A8	887-425611(F)	Input Amplifier Board	Beckman	1
C1, 4, 5, 6, 7	633-804715	Capacitor, F. Ceramic, 0.01 μ f, 50V	Sprague 19C214	5
C2	633-811294	Capacitor, F. Mica, 1.5pf, 600V	Skottie TCD-4-NPO	1
C3	633-838425	Capacitor, F. Ceramic, 22pf, 500V	Skottie TCD-4-NPO	1
CR1, 2, 6, 7, 8 9, 12, 13	755-420893	Diode, 893	Beckman	8
CR3, 4, 10, 11	755-431324	Diode, Special	Beckman	4
Q1, 2, 7, 8, 9	755-425735	Transistor, Special	Beckman	5
Q3, 4	755-838784	Transistor, Type 2N3565	Fairchild	2
Q10	755-838105	Transistor, Type 2N3638	Fairchild	1
R1, 20, 38	601-823387	Resistor, F. Comp., 47 Ω , 1/4W, 5%	Allen Bradley CB4705	3
R2, 4, 11, 18	601-822301	Resistor, F. Comp., 15K, 1/4W, 5%	Allen Bradley CB1535	4
R3, 29, 30	601-822326	Resistor, F. Comp., 1.2K, 1/4W, 5%	Allen Bradley CB1225	3
R5, 6	601-823386	Resistor, F. Comp., 39 Ω , 1/4W, 5%	Allen Bradley CB3905	2
R7, 10	601-822331	Resistor, F. Comp., 8.2K, 1/4W, 5%	Allen Bradley CB8225	2
R8, 28	601-823391	Resistor, F. Comp., 150 Ω , 1/4W, 5%	Allen Bradley CB1515	2
R9, 34	601-079172	Resistor, F. Comp., 820 Ω , 1/2W, 5%	Allen Bradley EB8215	2
R12	611-826874	Resistor, Var., W.W., 10K	Bourns 3067P-1-103	1
R13	601-822543	Resistor, F. Comp., 82K, 1/4W, 5%	Allen Bradley CB8235	1
R14	601-015082	Resistor, F. Comp., 200K, 1/2W, 5%	Allen Bradley EB2045	1
R15	601-822334	Resistor, F. Comp., 22K, 1/4W, 5%	Allen Bradley CB2235	1
R16	601-823908	Resistor, F. Comp., 220K, 1/4W, 5%	Allen Bradley CB2245	1
R17	601-822324	Resistor, F. Comp., 10K, 1/4W, 5%	Allen Bradley CB1035	1
R19	601-822295	Resistor, F. Comp., 2.7K, 1/4W, 5%	Allen Bradley CB2725	1
R31, 32	601-823394	Resistor, F. Comp., 330 Ω , 1/4W, 5%	Allen Bradley CB3315	2
R33	601-822369	Resistor, F. Comp., 680 Ω , 1/4W, 5%	Allen Bradley CB6815	1
R35, 36, 37	601-822297	Resistor, F. Comp., 4.7K, 1/4W, 5%	Allen Bradley CB4725	3
R39	601-822335	Resistor, F. Comp., 27K, 1/4W, 5%	Allen Bradley CB2735	1

INPUT AMPLIFIER SCHEMATIC DIAGRAM



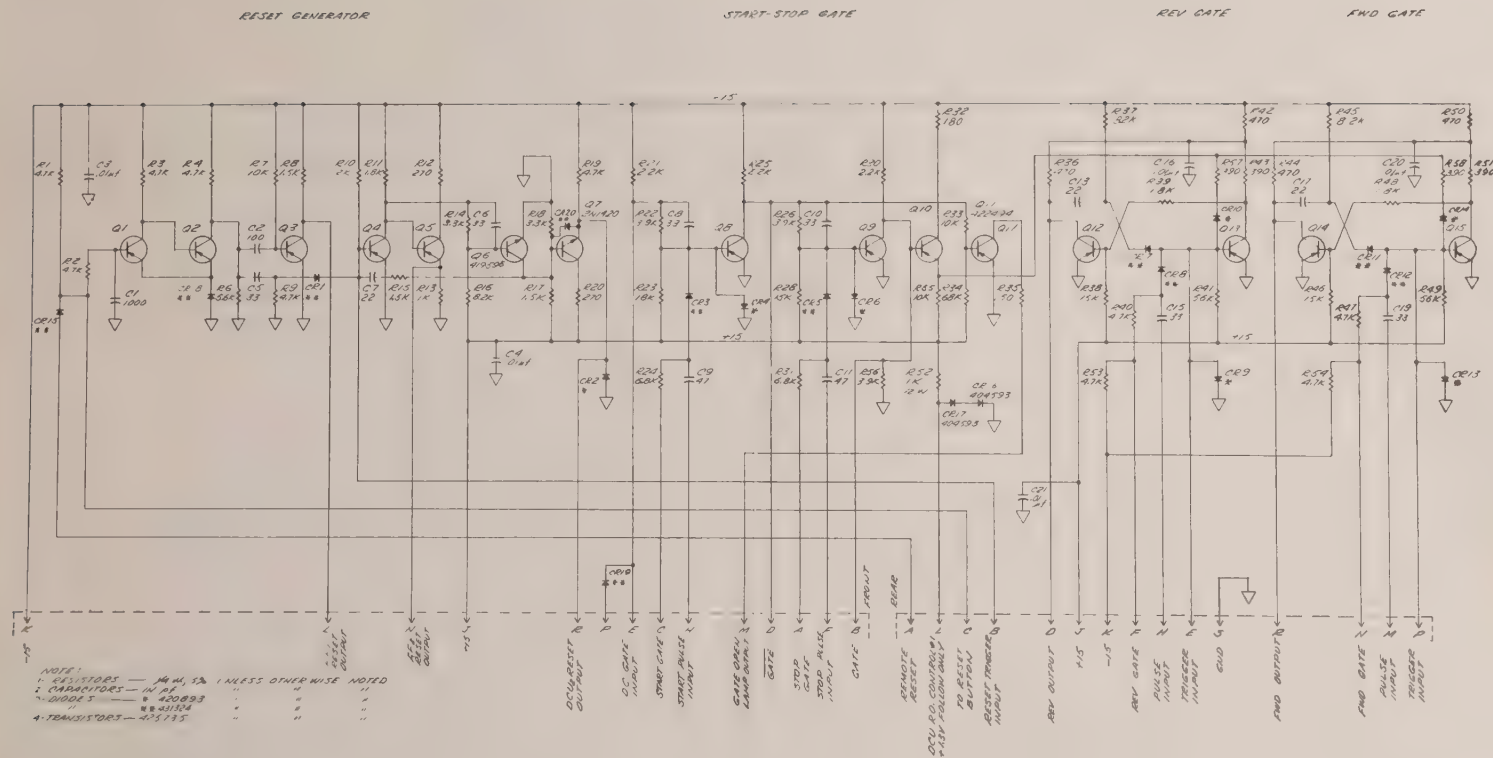
NOTE:
 1. RESISTORS: 1/4W, 5% UNLESS OTHERWISE NOTED
 2. * DIODES ARE B11 A733-431324
 3. ** DIODES ARE B11 A733-420893

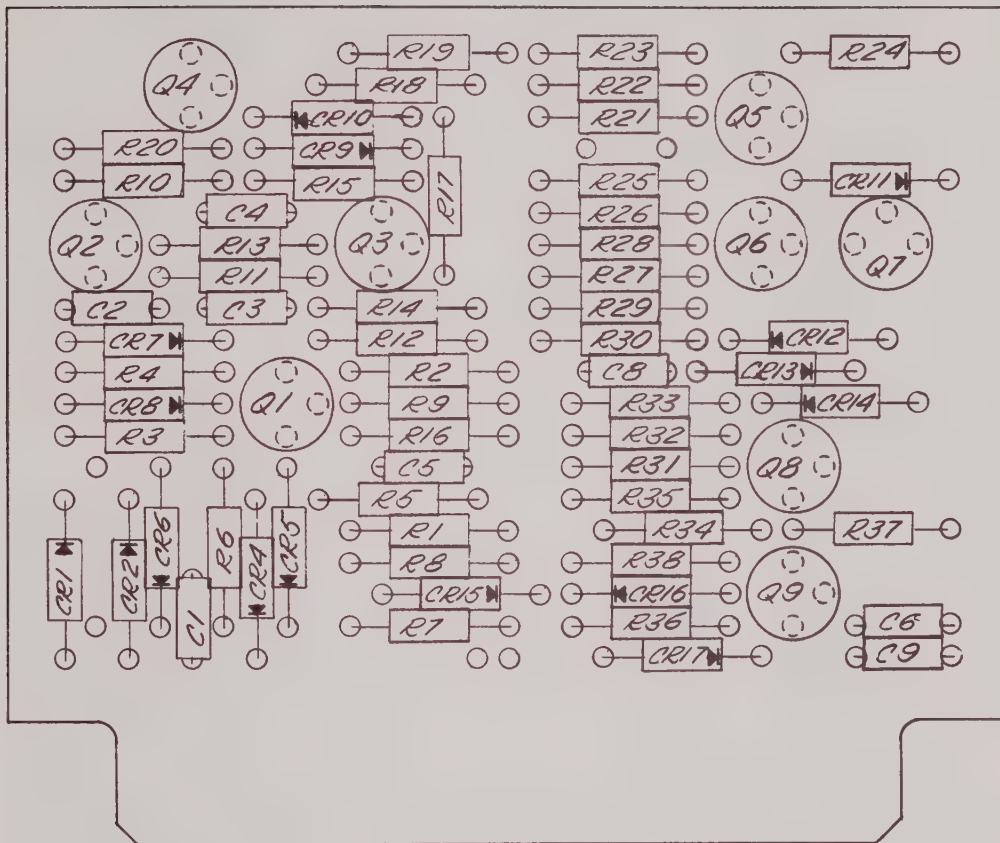


ACCUMULATOR CONTROL BOARD COMPONENT LAYOUT (A7)

ACCUMULATOR CONTROL BOARD (A7)

<u>Detail No.</u>	<u>Beckman Part No.</u>	<u>Description</u>	<u>Typical Manufacturer & No.</u>	<u>Qty./ Ass'y</u>
A7	887-425470 (G)	Accumulator Control Board	Beckman	1
C1	637-824028	Cap. 1000pf, 300V, 5%	Elmenco DM16E102J-300	1
C2	633-836932	Cap. 100pf, 500V, 10%	Skottie TSD-4-101-K	1
C3, 4, 16, 20, 21,	633-804715	Cap. .01 μ f. 50V	Sprague 19C214	5
C5, 6, 8, 10, 15, 19	633-838426	Cap. 33pf. 500V, 10%	Skottie TSD-4-330-K	6
C7, 13, 17	633-838425	Cap. 22pf, 500V, 10%	Skottie TSD-4-220-K	3
C9, 11	633-839568	Cap. 47pf, 500V, 10%	Skottie TSD-4-470K-1/2	2
CR1, 3, 5, 7, 8, 11, 12, 15, 18, 19, 20	755-431324	Diode, Special	Beckman	1 1
CR2, 4, 6, 9, 10, 13, 14	755-420893	Diode, Special "893"	Beckman	7
CR16, 17	755-404593	Diode, Special	Beckman	2
Q1, 2, 3, 4, 5, 8, 9, 10, 12, 13, 14, 15	755-425735	Transistor, Special	Beckman	1 2
Q6	755-419596	Transistor, Special	Beckman	1
Q7	755-817964	Transistor, 2N1420	Pacific Semiconductor	1
Q11	755-422494	Transistor, Special	Beckman	1
R1, 2, 3, 4, 9, 19, 40, 47, 53, 54	601-822297	Resistor, 4.7K, 1/4W, 5%	Allen Bradley CB4725	1 0
R6	601-823397	Resistor, 5.6K, 1/4W, 5%	Allen Bradley CB5625	1
R7, 33, 55	601-822324	Resistor, 10K, 1/4W, 5%	Allen Bradley CB1035	3
R8, 15, 17	601-822527	Resistor, 1.5K, 1/4W, 5%	Allen Bradley CB1525	3
R10	601-801803	Resistor, 12K, 1/4W, 5%	Allen Bradley CB1235	1
R11, 39, 48	601-822544	Resistor, 1.8 K, 1/4W, 5%	Allen Bradley CB1825	3
R12, 20	601-823393	Resistor, 270 Ω , 1/4W, 5%	Allen Bradley CB2745	2
R13	601-822308	Resistor, 1K, 1/4W, 5%	Allen Bradley CB1025	1
R14, 18	601-822296	Resistor, 3.3K, 1/4W, 5%	Allen Bradley CB3325	2
R16, 37, 45	601-822331	Resistor, 8.2K, 1/4W, 5%	Allen Bradley CB8225	3
R21, 25, 30	601-822328	Resistor, 2.2K, 1/4W, 5%	Allen Bradley CB2225	3
R22, 26, 56	601-822460	Resistor, 3.9K, 1/4W, 5%	Allen Bradley CB3925	3
R23	601-822303	Resistor, 18K, 1/4W, 5%	Allen Bradley CB1835	1
R24, 31	601-822299	Resistor, 6.8K, 1/4W, 5%	Allen Bradley CB6825	2
R28, 38, 46	601-822301	Resistor, 15K, 1/4W, 5%	Allen Bradley CB1535	3
R32	601-823392	Resistor, 180 Ω , 1/4W, 5%	Allen Bradley CB1815	1
R34	601-822798	Resistor, 68K, 1/4W, 5%	Allen Bradley CB6805	1
R35	601-823391	Resistor, 150 Ω , 1/4W, 5%	Allen Bradley CB1515	1
R36, 42, 44, 50,	601-823395	Resistor, 470 Ω , 1/4W, 5%	Allen Bradley CB4715	4
R41, 49	601-823903	Resistor, 56K, 1/4W, 5%	Allen Bradley CB5635	2
R 43, 51, 57, 58,	601-822371	Resistor, 390 Ω , 1/4W, 5%	Allen Bradley CB3915	4
R52	601-015038	Resistor, 1K, 1/2W, 5%	Allen Bradley EB1025	1

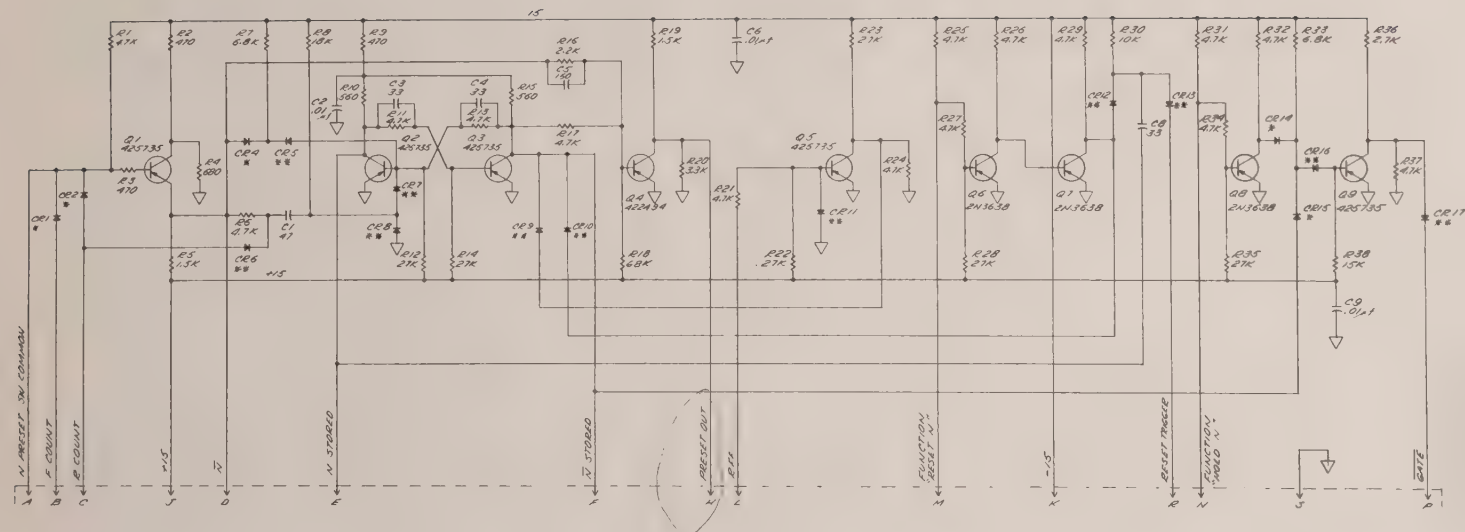




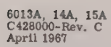
PRESET BOARD COMPONENT LAYOUT (A9, A10)

PRESET BOARD (A9, A10)
(Models 6014A, 6015A)

<u>Detail No.</u>	<u>Beckman Part No.</u>	<u>Description</u>	<u>Typical Manufacturer & No.</u>	<u>Qty./ Ass'y</u>
A9	887-426025(D)	Preset Board - Model 6004A (A9) Model 6005A (A9, A10)	Beckman Beckman	1 2
C1	633-839568	Cap., 47pf, 500V, 10%	Skottie TSD4-470K	1
C2, 6, 9	633-836864	Cap., 0.01 μ f, 50V	Sprague 19C214A6	3
C3, 4, 8	633-838426	Cap., 33pf, 500V, 10%	Skottie TSD4-330K	3
C5	633-836931	Cap., 150pf, 500V, 10%	Skottie TSD-4-151K	1
CR1, 2, 4, 14, 15	755-420893	Diode, Special	Beckman	5
CR5, 6, 7, 8, 9, 10, 11, 12, 13, 16, 17	755-815561	Diode, 1N3064 (CD6111)	Continental Device	11
Q1, 2, 3, 5, 9	755-425735	Transistor, Special	Beckman	5
Q4	755-422494	Transistor, Special	Beckman	1
Q6, 7, 8	755-838105	Transistor, 2N3638	Fairchild	3
R1, 6, 11, 13, 17, 21, 24, 25, 26, 27, 29, 31, 32, 34, 37	601-822297	Resistor, F.Comp., 4.7K, 1/4W, 5%	Allen Bradley CB4725	15
R2, 3, 9	601-823395	Resistor, F.Comp., 470 Ω , 1/4W, 5%	Allen Bradley CB4715	3
R4	601-822369	Resistor, F.Comp., 680 Ω , 1/4W, 5%	Allen Bradley CB6815	1
R5, 19	601-822527	Resistor, F.Comp., 1.5K, 1/4W, 5%	Allen Bradley CB1525	2
R7, 33	601-822299	Resistor, F.Comp., 6.8K, 1/4W, 5%	Allen Bradley CB6825	2
R8	601-822303	Resistor, F.Comp., 18K, 1/4W, 5%	Allen Bradley CB1835	1
R10, 15	601-823396	Resistor, F.Comp., 560 Ω , 1/4W, 5%	Allen Bradley CB5615	2
R12, 14, 22, 28, 35	601-822335	Resistor, F.Comp., 27K, 1/4W, 5%	Allen Bradley CB2735	5
R16	601-822328	Resistor, F.Comp., 2.2K, 1/4W, 5%	Allen Bradley CB2225	1
R18	601-822798	Resistor, F.Comp., 68K, 1/4W, 5%	Allen Bradley CB6835	1
R20	601-822296	Resistor, F.Comp., 3.3K, 1/4W, 5%	Allen Bradley CB3325	1
R23, 36	601-822295	Resistor, F.Comp., 2.7K, 1/4W, 5%	Allen Bradley CB2725	2
R30	601-822324	Resistor, F.Comp., 10K, 1/4W, 5%	Allen Bradley CB1035	1
R38	601-822301	Resistor, F.Comp., 15K, 1/4W, 5%	Allen Bradley CB1535	1



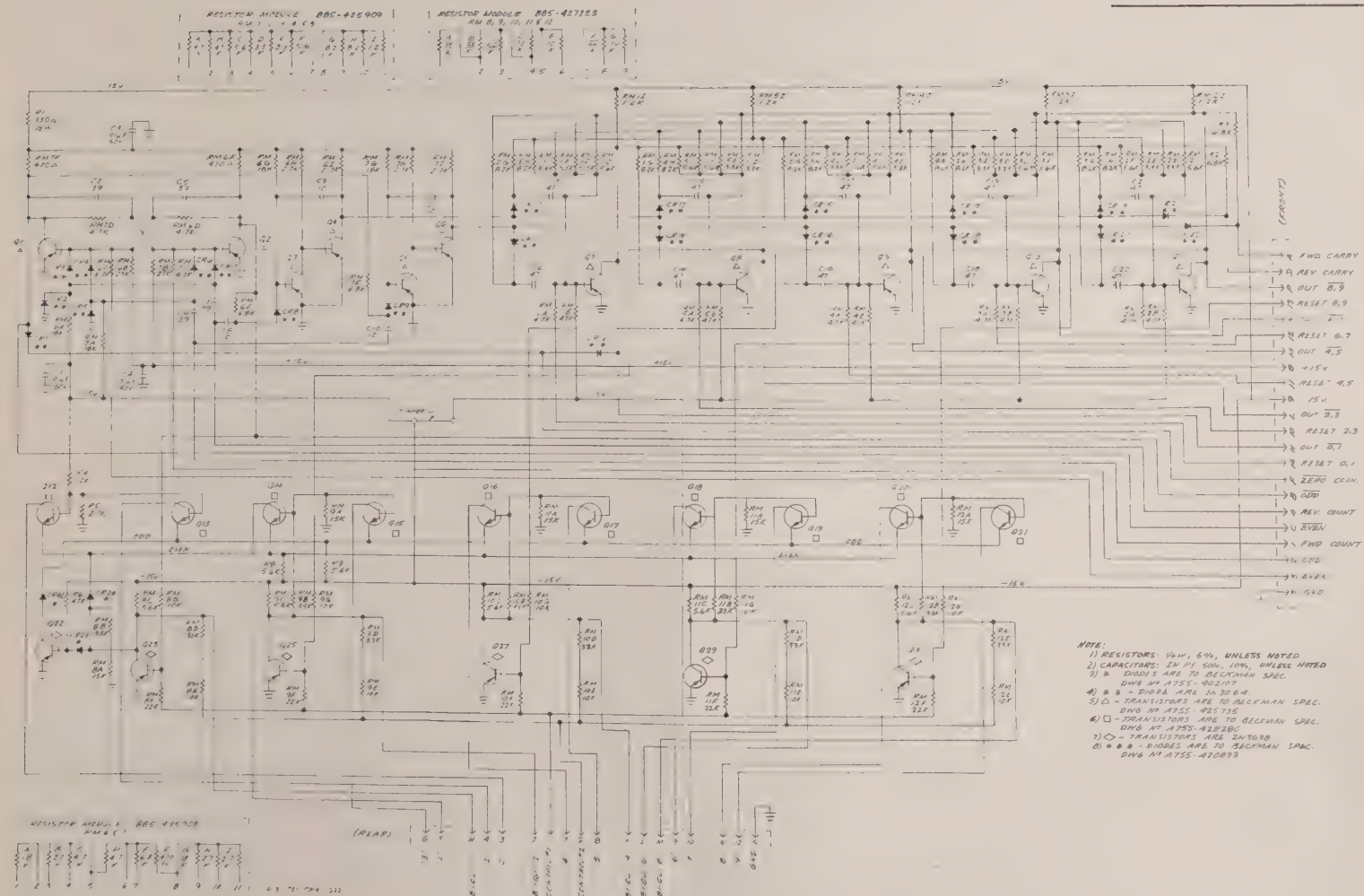
NOTES:
RESISTORS — MIN. 1% UNLESS OTHERWISE NOTED.
CAPACITORS — MIN. 1%
DIODES — 40083
" — 1N3064

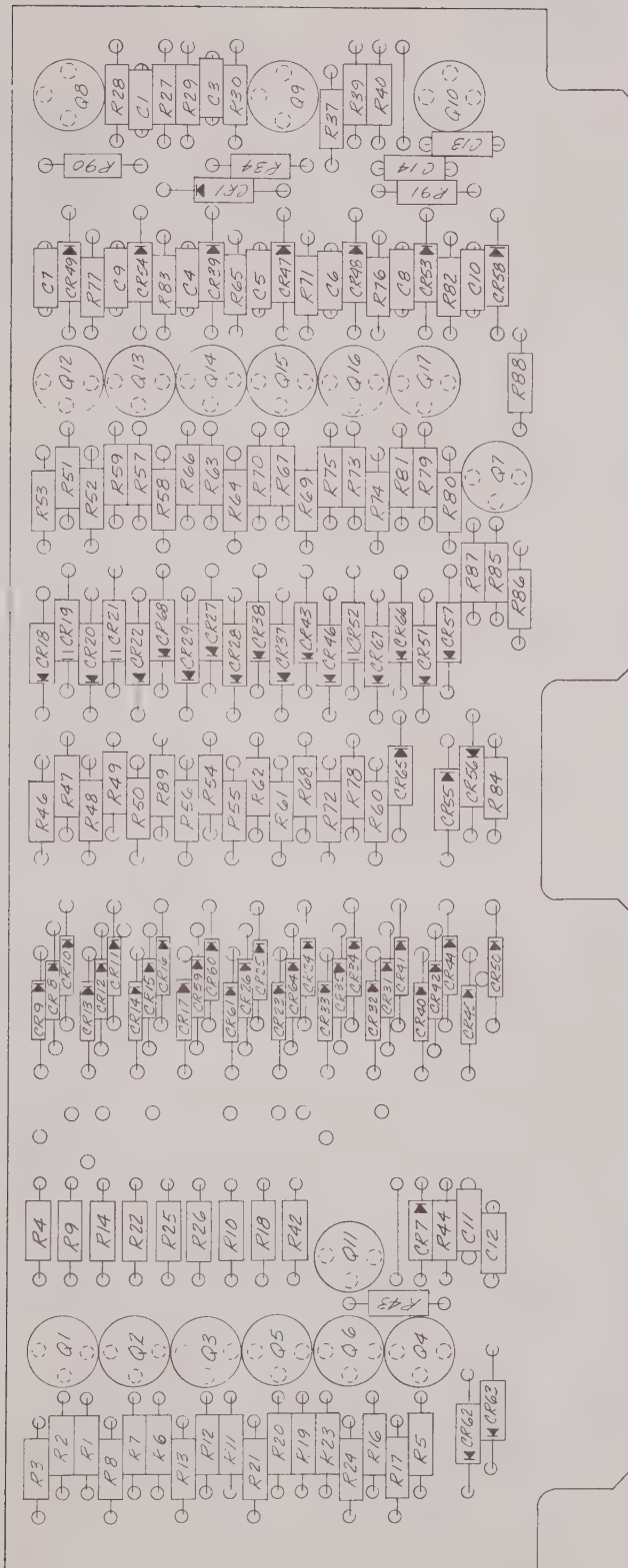


FORWARD/REVERSE DCU W/GLO-TUBE
READOUT BOARD (A2 THRU A6)

<u>Detail No.</u>	<u>Beckman Part No.</u>	<u>Description</u>	<u>Typical Manufacturer & No.</u>	<u>Qty. / Ass'y</u>
A2 thru A6	887-428000(C)	Fwd./Rev. DCU w/Glo-Tube Readout Board	Beckman	5
C1, 3, 4	633-836864	Cap., F. Cerm., 0.01 μ f, 50V	Sprague 19C214A6	3
C2, 5, 6, 7	633-839570	Cap., F.Cerm., 39pf, 500V, 10%	Skottie TSD-4-390-K-1/2	4
C8, 9, 10, 11	633-839569	Cap., F. Cerm., 10pf, 500V, 10%	Skottie TSD-40-100K-1/2	4
C12 thru 21	633-839568	Cap., F. Cerm., 47pf, 500V, 10%	Skottie TSD-470-K-1/2	10
CR1 thru CR22	755-431324	Diode, Silicon IN3064	Beckman	22
CR23, 24, 42	755-402107	Diode, Silicon, Special	Beckman	3
Q1 thru Q11	755-425735	Transistor, Special	Beckman	11
Q12 thru Q21	755-428280	Transistor, Special	Beckman	10
Q22, 23, 25, 27, 29, 31	755-838105	Transistor, 2N3638	Sylvania	6
R1	601-015443	Resistor, F.Comp. 330 Ω , 1/2W, 5%	Allen Bradley EB3315	1
R2, 3	601-822299	Resistor, F.Comp. 6.8K, 1/4W, 5%	Allen Bradley CB6825	2
R4	601-801803	Resistor, F.Comp. 12K, 1/4W, 5%	Allen Bradley CB1235	1
R5	601-822295	Resistor, F.Comp. 2.7K, 1/4W, 5%	Allen Bradley CB2725	1
R6	601-823902	Resistor, F. Comp. 47K, 1/4W, 5%	Allen Bradley CB4735	1
R8, 9	601-822397	Resistor, F.Comp. 5.6K, 1/4W, 5%	Allen Bradley CB5625	2
RM1 thru RM5	855-425909	Resistor, Module	Beckman	5
RM6, 7	855-425908	Resistor, Module	Beckman	2
RM8 thru RM12	855-427223	Resistor, Module	Beckman	5

FORWARD/REVERSE DCU
W/GLO-TUBE READOUT
SCHEMATIC DIAGRAM



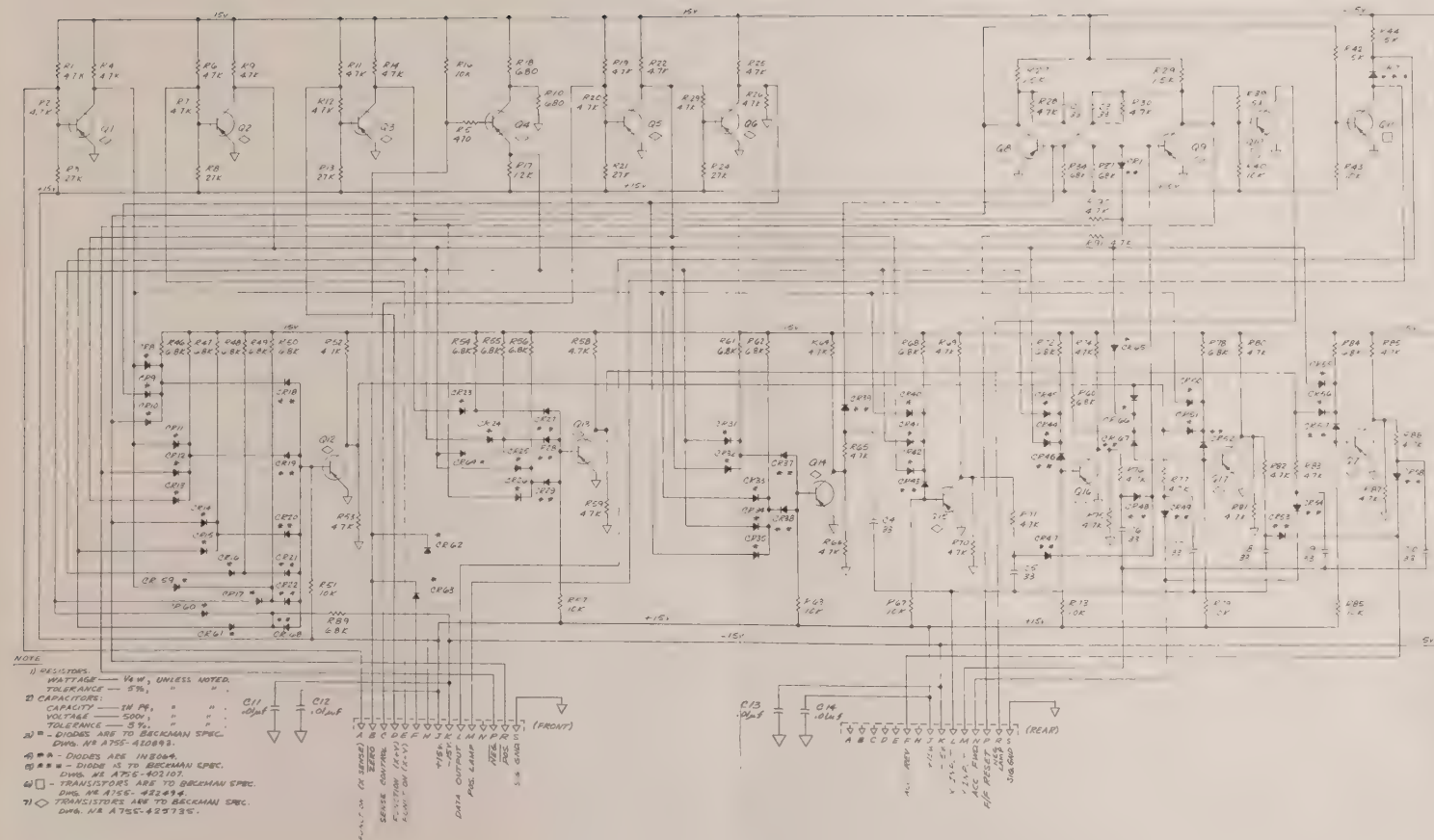


FORWARD/REVERSE LOGIC BOARD
COMPONENT LAYOUT (A12)

FORWARD/REVERSE LOGIC BOARD (A12)

<u>Detail No.</u>	<u>Beckman Part No.</u>	<u>Description</u>	<u>Typical Manufacturer & No.</u>	<u>Qty./ Ass'y</u>
A12	887-429806 (A)	Fwd./Rev. Logic Board	Beckman	1
C1, 3 thru 10	633-838426	Cap. F.Cerm, 33pf, 500V, 10%	Skottie TSD-4-330K	9
C11, 12, 13, 14	633-836864	Cap. F.Cerm, 0.01 μ f, 50V	Sprague 19C214A6	4
CR1, 18, 19, 20, 21, 22, 27, 28, 29, 37, 38, 39, 43, 46, 47, 48, 49, 52, 53, 54, 57, 58, 67, 68	755-431324	Diode, Silicon CD6111	Beckman	24
CR7	755-402107	Diode, Special 1N95	Beckman	1
CR8 thru 17, 23, 24, 25, 26, 31, 32, 33, 34, 35, 40, 41, 42, 44, 45, 50, 51, 55, 56, 59 thru 66	755-420893	Diode, Special	Beckman	36
Q1 thru 9, 12 thru 17	755-425735	Transistor, Special	Beckman	15
Q10, 11	755-422494	Transistor, Special	Beckman	2
R1, 2, 4, 6, 7, 9, 11, 12, 14, 19, 20, 22, 23, 25, 26, 28, 30, 52, 53, 58, 59, 64, 65, 66, 69, 70, 71, 74, 75, 76, 77, 80, 81, 82, 83, 86, 87, 88, 90, 91	601-822297	Resistor, F.Comp., 4.7K, 1/4W, 5%	Allen Bradley CB4725	40
R3, 8, 13, 21, 24	601-822335	Resistor, F.Comp., 27K, 1/4W, 5%	Allen Bradley CB2735	5
R5	601-823395	Resistor, F.Comp., 470 Ω , 1/4W, 5%	Allen Bradley CB4715	1
R10, 18	601-822369	Resistor, F.Comp., 680 Ω , 1/4W, 5%	Allen Bradley CB6815	2
R16, 40, 43, 51, 57, 63, 67, 73, 79, 85	601-822324	Resistor, F.Comp., 10K, 1/4W, 5%	Allen Bradley CB1035	10
R17	601-822326	Resistor, F.Comp., 1.2K, 1/4W, 5%	Allen Bradley CB1225	1
R27, 29, 39, 42	601-822527	Resistor, F.Comp., 1.5K, 1/4W, 5%	Allen Bradley CB1525	4
R34, 37	601-822798	Resistor, F.Comp., 68K, 1/4W, 5%	Allen Bradley CB6835	2
R44	601-822301	Resistor, F.Comp., 15K, 1/4W, 5%	Allen Bradley CB1535	1
R46, 47, 48, 49 50, 54, 55, 56, 60, 61, 62, 68, 72, 78, 84, 89	601-822299	Resistor, F.Comp., 6.8K, 1/4W, 5%	Allen Bradley CB6825	16

FORWARD/REVERSE LOGIC SCHEMATIC DIAGRAM





REGULATOR BOARD (A1)
(Models 6013A, 6014A, 6015A)

<u>Detail No.</u>	<u>Beckman Part No.</u>	<u>Description</u>	<u>Typical Manufacturer & No.</u>	<u>Qty./ Ass'y</u>
A1	887-426753 E	Regulator Board	Beckman	1
C1, 2	631-844520	Capacitor, Elect., 1 μ f, 35V, $\pm$ 20%	Kemet K1P35	2
CR1, 3, 5	755-404593	Diode, Special	Beckman	3
CR2	755-814019	Diode, Zener, 1N754 A	Motorola	1
CR6, 7	755-416842	Diode, Special	Beckman	2
CR8	755-814045	Diode, 1N751A	Motorola	1
Q1, 4	755-817210	Transistor, Silicon, 2N1034	Texas Instruments	2
Q2, 5	755-836485	Transistor, Germanium, 2N2374	Texas Instruments	2
Q3, 6	755-800398	Transistor, Germanium, 2N404	Sylvania	2
Q7	755-817964	Transistor, Silicon, 2N1420	P.S.I.	1
R1, 8	601-008080	Resistor, F.Comp., 2.2K, 1/2W, 10%	Allen Bradley EB2221	2
R2, 9	601-822327	Resistor, F.Comp., 220 Ω , 1/4W, 5%	Allen Bradley CB2215	2
R3, 11	601-812856	Resistor, F.Comp., 2.2K, 1/4W, 10%	Allen Bradley CB2221	2
R4	601-823111	Resistor, F.Comp., 1K, 1/4W, 10%	Allen Bradley CB1021	1
R5	601-822369	Resistor, F. Comp., 680 Ω , 1/4W, 5%	Allen Bradley CB6815	1
R6, 14	611-812861	Resistor, Var., W.W., 200 Ω	C.T.S. Series 111	2
R7	601-823396	Resistor, F.Comp., 560 Ω , 1/4W, 5%	Allen Bradley CB5615	1
R12, 20	601-822308	Resistor, F.Comp., 1K, 1/4W, 5%	Allen Bradley CB1025	2
R13, 15	601-822306	Resistor, F.Comp., 820 Ω , 1/4W, 5%	Allen Bradley CB8215	2
R16	607-844498	Resistor, F. Film, 68K, 1%	IRC MEC-TO	1
R17	607-821212	Resistor, F. Film, 1.96K, 1/8W, 1%	IRC CEA-TO	1
R18	601-822299	Resistor, F. Comp. 6.8K, 1/4W, 5%	Allen Bradley CB6825	1
R19	601-822544	Resistor, F. Comp. 1.8K, 1/4W, 5%	Allen Bradley CB1825	1
R21	601-822326	Resistor, F. Comp. 1.2K, 1/4W, 5%	Allen Bradley CB1225	1
R22	611-815619	Resistor, Var. W.W., 500 Ω , 1.5W, 20%	CT.S. Series 111	1
	864-412958	Transistor Pad	Beckman	7

(Models 6013A, 6014A, 6015A)

6013A, 14A, 15A
C 426752-Rev. E
April 1967

Beckman*

(4-67) 6013A, 14A, 15A

LOGIC SYMBOLS AND TYPICAL CIRCUITS

This section describes logic symbols as used in this manual. Typical circuit configurations are shown with each symbol. Actual circuits used in this instrument may be modifications of these typical circuits.

A.1 AND GATE

The AND gate is a multiple-input circuit which requires that all inputs be present in order to produce an output.

A typical AND gate is shown in figure A-1.

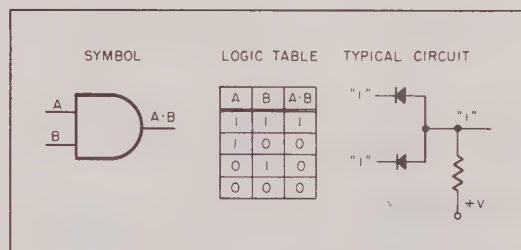


Fig. A-1. AND Gate

A.2 OR GATE

The OR gate requires the presence of one or more inputs in order to produce an output.

A typical OR gate is shown in figure A-2.

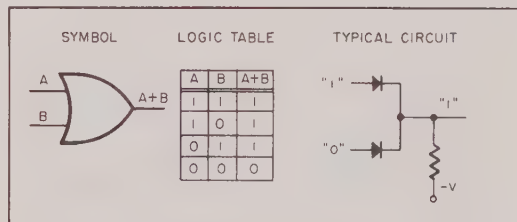


Fig. A-2. Typical OR Gate

A.3 NAND GATE

The NAND gate is a multiple-input circuit which requires all inputs to be logic 1 in order to produce a logic 0 output.

A typical NAND gate is shown in figure A-3.

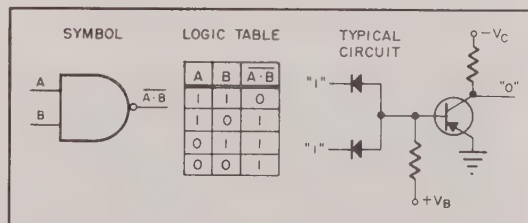


Fig. A-3. Typical NAND Gate

A.4 NOR GATE

The NOR gate is a multiple-input circuit which requires all inputs to the gate to be logic 0 to produce a logic 1 output.

A typical NOR gate is shown in figure A-4.

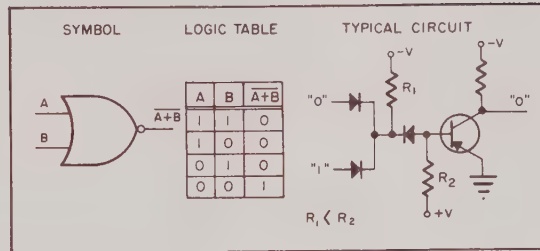


Fig. A-4. Typical NOR Gate

A.5 POSITIVE AND NEGATIVE ZONE LOGIC

Unless stated otherwise, all logic symbols used in this publication refer to positive zone logic. Positive and negative zone logic are defined as follows.

1) Positive Zone Logic:

Positive zone logic exists when all pulses and/or levels occur on the positive side of the zero line.

When logic 1 is more positive than logic 0, it is called "positive zone, positive true". When logic 1 is less positive than logic 0, it is called "positive zone, negative true".

2) Negative Zone Logic:

Negative zone logic exists when all pulses and/or levels occur on the negative side of the zero line.

When logic 1 is less negative than logic 0, it is called "negative zone, positive true". When logic 1 is more negative than logic 0, it is called "negative zone, negative true".

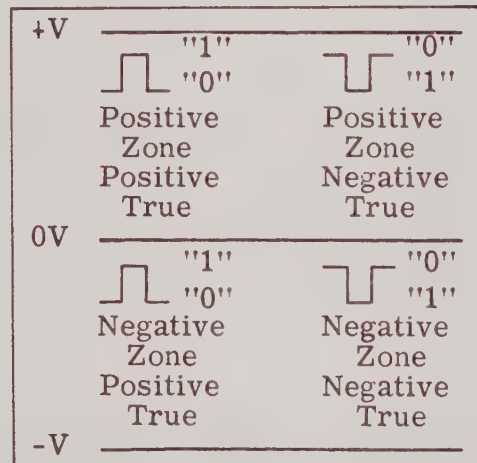


Fig. A-5. Positive and Negative Zone Logic

A.6 INVERTERS AND EMITTER FOLLOWERS

Logic inverting circuits provide a method of converting a logic 0 to a logic 1 or vice versa. Figure A-6 shows the inversion operation and a typical inverting circuit.

An emitter follower circuit is represented by the  symbol (see figure A-6A). The circuit is so named because the output at the emitter follows the input in phase. This circuit may be used as a current amplifier or as a coupling or impedance matching element.

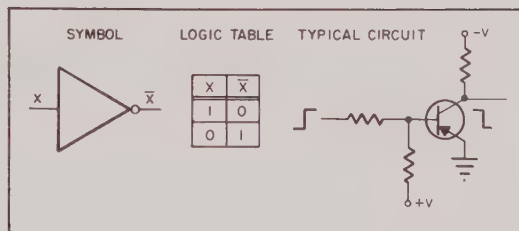


Fig. A-6. Typical Inverter

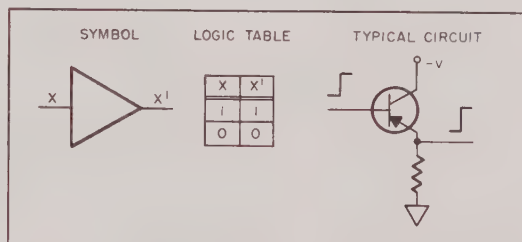


Fig. A-6A. Typical Emitter Follower

A.7 INVERTED TRUE INPUTS

When one input to a logic circuit requires a negative true signal where a positive true signal is usually required, a "not" (o) indication is shown at the particular input terminal of the logic symbol.

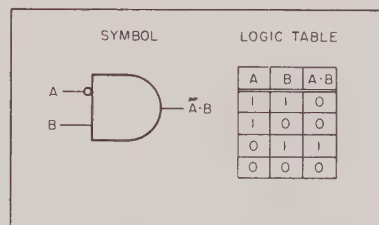


Fig. A-7. AND Gate Using Inverter Control Voltage Level

A.8 FLIP-FLOPS

The bistable multivibrator, or flip-flop, is characterized by having two states, logic 1 or logic 0. Since both states are stable, the binary is commonly used in memory circuits, counting circuits, and shift registers.

A typical flip-flop is shown in figure A-8. In the usual configuration, there are two input lines (logic 1 and logic 0) and two outputs (logic 1 and logic 0).

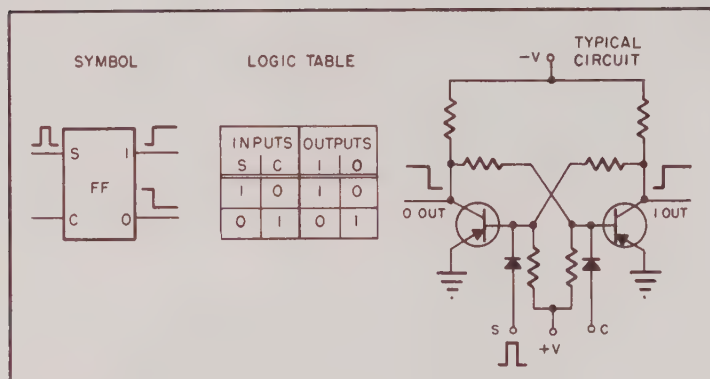


Fig. A-8. Typical Flip-Flop

A signal applied to the set input results in a logic 1 signal at the logic 1 output and a logic 0 signal at the logic 0 output. Conversely, a signal applied to the clear input results in a logic 0 at the logic 1 output and a logic 1 at the logic 0 output.

Positive Pulse Steering

Shown in figure A-8A is a flip-flop using PNP transistors and positive pulse steering. The circuit can exist in either of two stable states: Q1 on, Q2 off; or Q1 off, Q2 on.

Positive input pulses trigger the binary from one stable state to the other through one of the pulse-steering diodes (CR1 or CR2).

Circuit Description

With Q1 conducting and Q2 cut off, a positive input pulse passes through CR1 to the base of Q1. This turns Q1 off. As Q1 turns off, load current decreases and the collector potential approaches -15 volts. This negative transient is coupled through capacitor C1 to the base of Q2, turning Q2 on. Current through Q2 increases and its collector potential rises toward ground. Under these conditions, divider network R6-R4 maintains a positive potential at the base of Q1 to keep it cut off.

The flip-flop remains in this stable state (Q1 off, Q2 on) until the next positive input arrives. At this time, Q2 cuts off, Q1 conducts, and the binary resumes its original state.

————— NOTE —————

Logic 1 and logic 0 inputs may also be referred to as set and clear inputs.

CONTENTS

DJ OPTION

	<u>Page</u>
Specifications	J-1
Operation	J-1
Circuitry	J-2
Table J-1. Four-Line Binary Code.	J-2
Table J-2. Output Connector J4 Pin Numbering.	J-3
Fig. J-1. Wiring of the Accessory Command Board.	J-5
Fig. J-2. Wiring of the Data Output Connector, J4.	J-6
Accessory Command Board Component Layout and Parts List (C426331-H)	J-7
Accessory Command Schematic Diagram (D426175-H)	J-7a
Bi-Quinary DCU (Fwd. Only, w/Glo-Tube & BCD Readout) Board and Parts List (D434231-B)	J-8
Bi-Quinary DCU (Fwd. Only, w/Glo-Tube & BCD Readout) Schematic Diagram (D434232-B)	J-8a
Bi-Quinary DCU (Fwd./Rev., w/Glo-Tube & BCD Readout) Board and Parts List (D429385-C)	J-9
Bi-Quinary DCU (Fwd./Rev., w/Glo-Tube & BCD Readout) Schematic Diagram (D429386-C)	J-9a

DJ OPTION

For all Bi-Quinary DCU's (Fwd. Only, Non-Latching BCD) assemblies stamped with revision letter "A":

- 1) To take the schematic diagram (dwg. no. D434232-Rev. B) to revision level "A", change all diodes (part no. 755-431324) to 1N3064; change R5 from 2.2K to 2.7K, 1/4W, 5% (part no. 601-822295); delete CR43 and return emitters of Q25, Q27, Q29, and Q31 to ground.

Change the schematic revision letter to "A".

- 2) Change the component layout revision letter to "A" to agree with the above. Also, change the parts list to agree with 1) above.

DJ OPTION

1-2-4-8 BCD Data Output

GENERAL

The DJ options provide five digits of four-line 1-2-4-8 BCD data for external use such as driving a printer, tape punch intercoupler, or other data receiving network. The options available are as follows: the DJ option with Models 6003A, 6004A, and 6005A Accumulators; the DJ1 option with Models 6013A, 6014A, and 6015A Accumulators; the DJ2 option with the Model 6010A EPUT[®] Meter. Models 6020A and 6030A EPUT Meters are equipped with BCD output as standard equipment.

SPECIFICATIONS

The BCD output is available at the rear panel on a 50-pin connector (Amphenol type 57-40500). A data ready signal (gate closed) is available at the connector for a 50-millisecond interval as a change from logic 1 to logic 0 takes place. In the DJ1 option for Models 6013A, 6014A, and 6015A, a plus sign is indicated by a binary 0 and a minus sign by a binary 1 on the plus or minus line. In models having the DM option, the sixth digit and overflow signals are available at the rear connector. Overflow is indicated by binary 1 and no overflow is indicated by binary 0.

All binary outputs consist of a logic 0 (-10 to -15 volts) or a logic 1 (0 to -0.8 volts). Available current is 0.2 milliamperes maximum for logic 0 and 5 milliamperes maximum for logic 1. The 50-pin connector is wired to the readout lines of each DCU to operate auxiliary equipment, such as printers, display units, or data converters. Table J-1 gives the binary four-line code. Table J-2 shows the output connector pin numbering.

OPERATION

The DJ and DJ1 options add an Accessory Command Printed Circuit Board. The DJ2 option does not require an Accessory Command board. This board provides an accessory command output which consists of a 50 millisecond or longer data ready pulse. This pulse is automatically generated when the count gate closes. The gate closes automatically, or it can be closed manually.

Table J-1. Four-Line Binary Code

Decimal Digit Registered	1st Binary (Wt. 1)	2nd Binary (Wt. 2)	3rd Binary (Wt. 4)	4th Binary (Wt. 8)
0	0	0	0	0
1	1	0	0	0
2	0	1	0	0
3	1	1	0	0
4	0	0	1	0
5	1	0	1	0
6	0	1	1	0
7	1	1	1	0
8	0	0	0	1
9	1	0	0	1

The accessory inhibit input to the Accessory Command Board is used to stop the recycle of the Accessory Command Board until the unit receiving the data (such as a printer) has stored the information. The accessory inhibit is produced by grounding pin 25 of J4. After the accessory inhibit has been removed, the accessory command circuit recycles, clears the accumulator and becomes ready to accept more information.

The sequence is as follows:

The accumulator counts up to a preset number N or the gate is closed manually. After the gate closes, the single-shot in the Accessory Command Board generates a data ready signal. The printer (or any other data storing network) receives the data ready signal and sends back an accessory inhibit signal. The accessory inhibit signal remains on until the printer has acted on the data, and then the inhibit signal is removed. The single-shot then recycles, the accumulator clears, the count gate is ready to open, and a new cycle begins.

CIRCUITRY

Refer to Accessory Command Schematic Diagram (dwg. no. D426175), and Accessory Command Board Component Layout (dwg. no. C426331).

Table J-2. Output Connector J4 Pin Numbering

Displayed Decimal	1st Binary (Wt. 1)	2nd Binary (Wt. 2)	3rd Binary (Wt. 4)	4th Binary (Wt. 8)
10^0	Pin 1	Pin 2	Pin 26	Pin 27
10^1	Pin 3	Pin 4	Pin 28	Pin 29
10^2	Pin 5	Pin 6	Pin 30	Pin 31
10^3	Pin 7	Pin 8	Pin 32	Pin 33
10^4	Pin 9	Pin 10	Pin 34	Pin 35
10^5 (DM option)	Pin 11	Pin 12	Pin 36	Pin 37
Pin 24 - <u>Plus or Minus Line</u>. Carries a logic 0 for a plus sign or a logic 1 for a minus sign. Connection in Models 6013A, 6014A, and 6015A Reversing Accumulators only. Pin 25 - <u>Inhibit Recycle</u>. Carries an "inhibit recycle" command from the accessory to the instrument. When this pin is at ground, the instrument cannot recycle. Pin 49 - <u>Accessory Command</u>. Carries a control signal from the instrument to the auxiliary recorder. This pin is negative (-10 volts or more) for 50 milliseconds or more (depending on display time) and positive (ground potential, approximately) from the time of reset until the next accessory command. Pin 50 - <u>Ground</u>.				

The wiring of the Accessory Command Board for the DJ and DJ1 options are shown in Figure J-1. Wiring of the Data Output Connector, J4, is shown in Figure J-2.

The DCU's with BCD data outputs for Model 6010A are incorporated in the instrument as standard equipment. However, the Data Output Connector, J4, and wiring harness are not part of the standard instrument.

The DCU's used by the DJ and DJ1 options are different from those in the standard instrument in that they have provisions for BCD readout. For the DCU's used in the DJ option for Models 6003A, 6004A, and 6005A, refer to Bi-Quinary DCU (Forward Only - Non-Latching - BCD) Schematic Diagram (dwg. no. D434232), and Bi-Quinary DCU (Forward Only - Non-Latching - BCD) Board Component Layout (dwg. no. D434231). For the DCU's used in the DJ1 option for Models 6013A, 6014A, and

6015A refer to Bi-Quinary DCU (Forward/Reverse - Non-Latching - BCD) Schematic Diagram (dwg. no. D429386), and Bi-Quinary DCU (Forward/Reverse - Non-Latching - BCD) Board Component Layout (dwg. no. D429385). For the electrical components contained in the above assemblies, refer to the respective parts lists.

If the DJ options are used with the DM option, six DCU's are included in the instrument; otherwise, five are used.

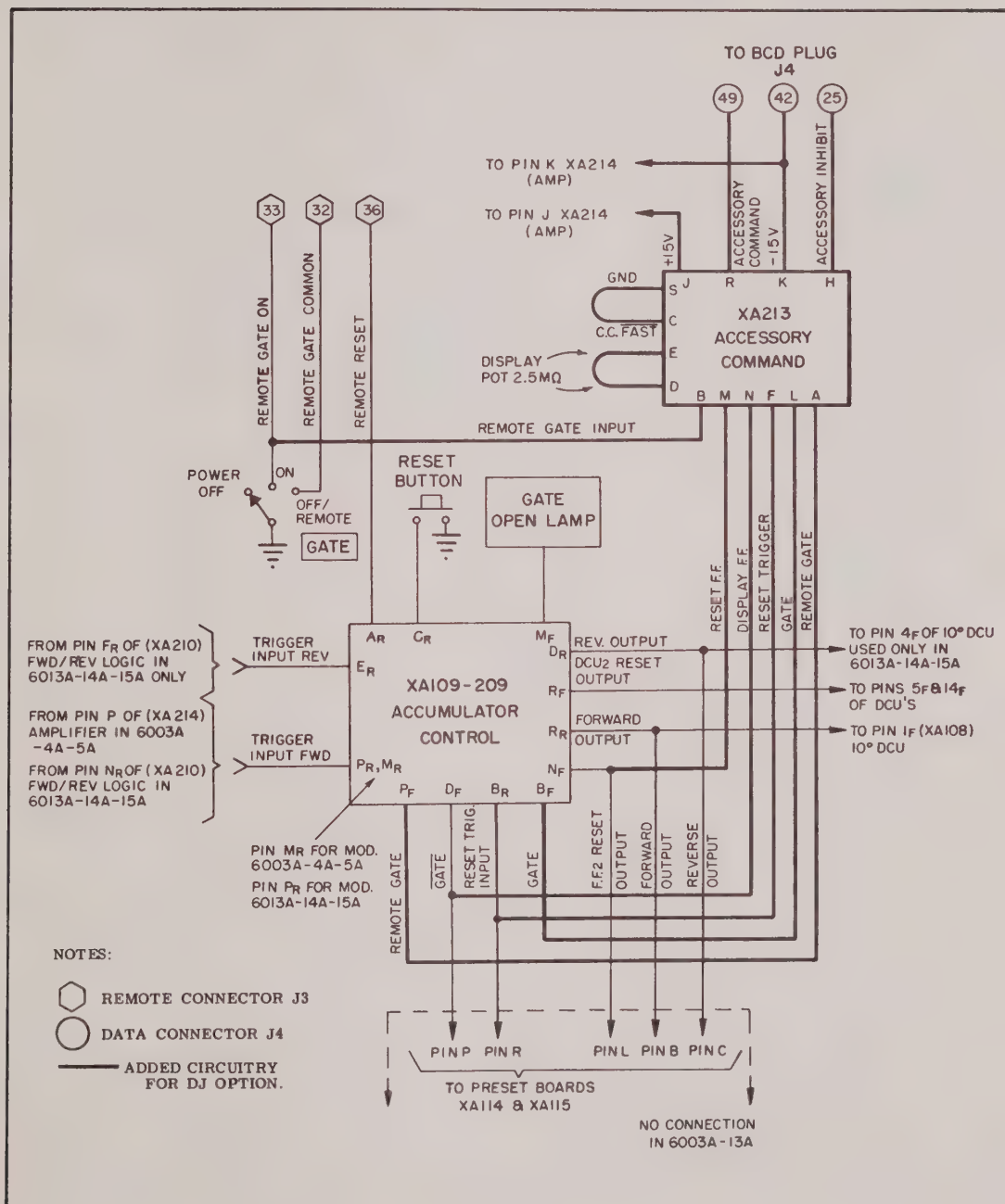


Fig. J-1. Wiring of the Accessory Command Board

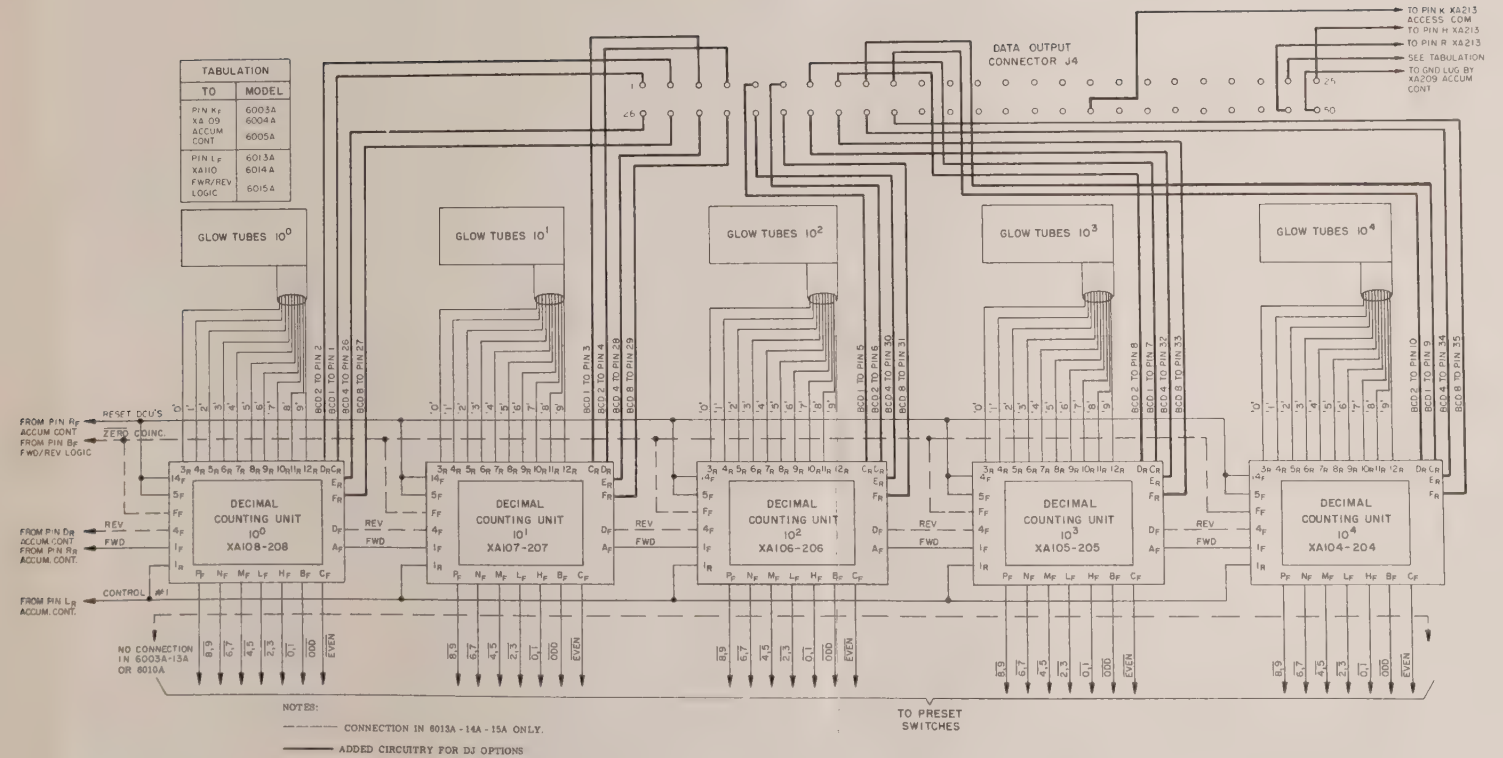
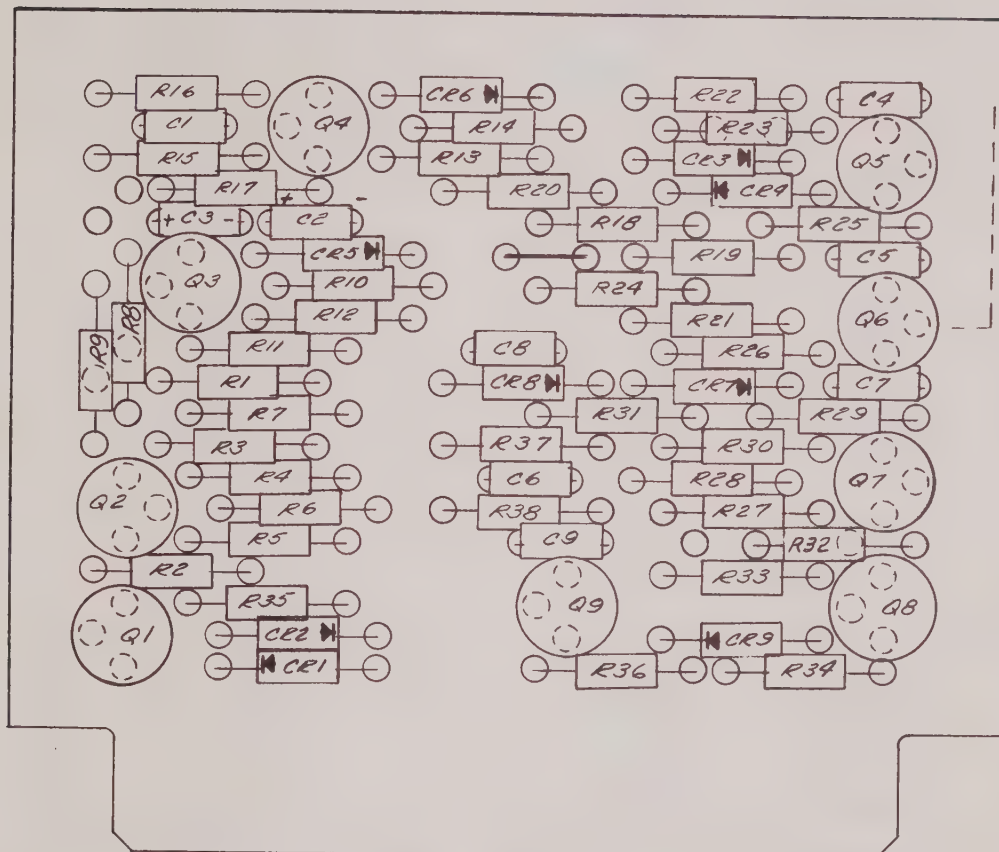


Fig. J-2. Wiring of the Data Output Connector, J4.



ACCESSORY COMMAND BOARD COMPONENT LAYOUT

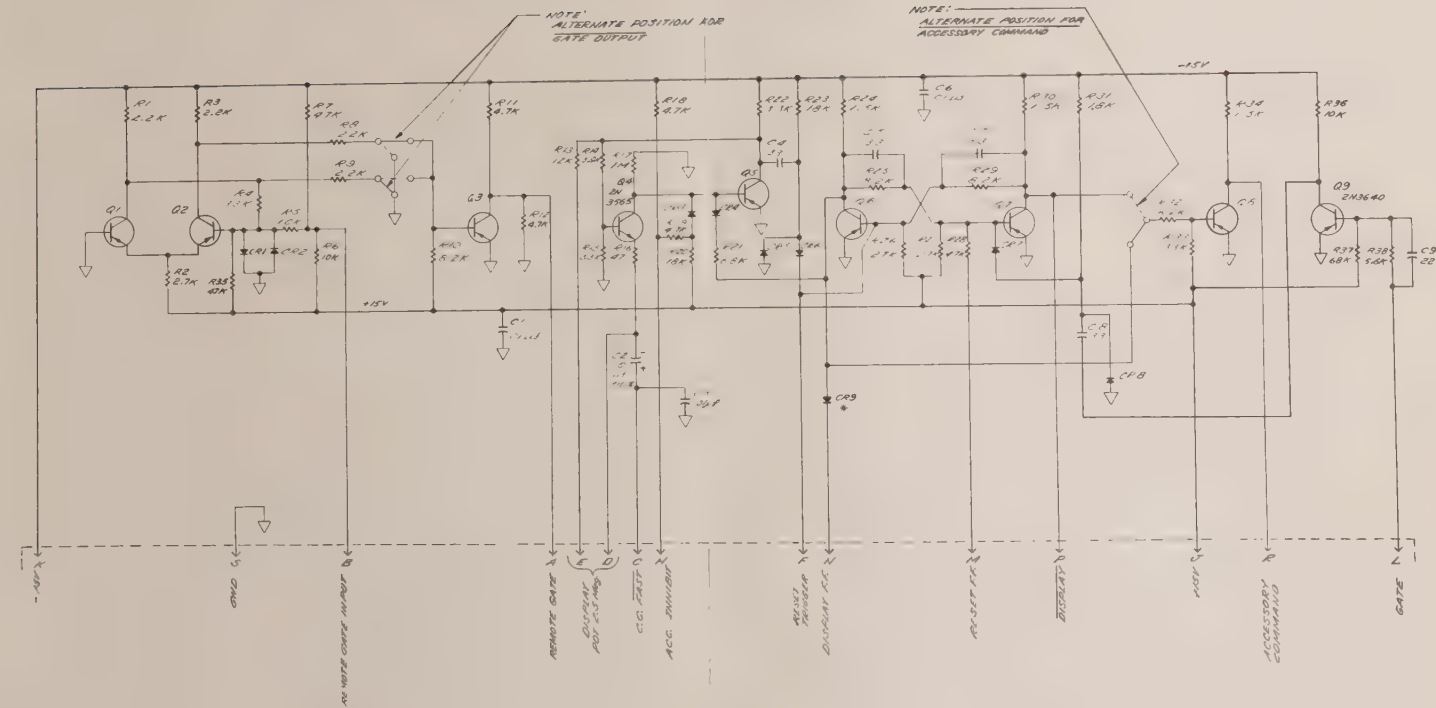
PARTS LIST

(C426331-H)

ACCESSORY COMMAND BOARD

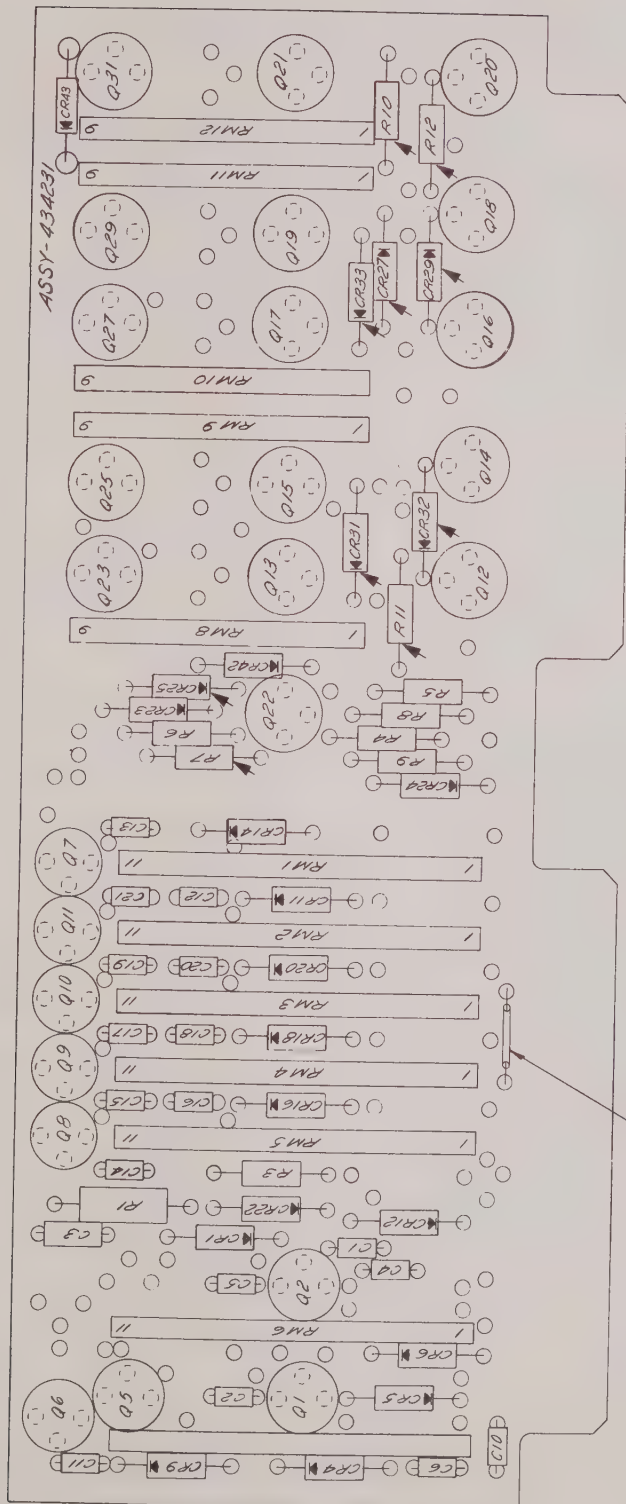
<u>Detail No.</u>	<u>Beckman Stock No.</u>	<u>Description</u>	<u>Typical Manufacturer & No.</u>	<u>Qty./ Ass'y</u>
C1, 3, 6	633-804715	Capacitor, Cerm., 0.01 μ f, 50V	Sprague 19C214	3
C2	631-839718	Capacitor, Elect., 10 μ f, 20V	Semcor TSD2-20-106	1
C4, 5, 7, 8	633-838426	Capacitor, Cerm., 33pf, 200V, 10%	Skottie TSD-4-330-K	4
C9	633-838425	Capacitor, Cerm., 22pf, 500V, 10%	Skottie TSD-4-220-K	1
CR1 thru CR8	755-431324	Diode, Special	Beckman	8
CR9	755-420893	Diode, Special	Beckman	1
Q1, 2, 3, 5, 6, 7, 8, 9	755-425735	Transistor, Special	Beckman	8
Q4	755-838784	Transistor, 2N3565	Fairchild	1
R1, 3, 8, 9	601-822328	Resistor, F. Comp., 2.2K, 1/4W, 5%	Allen Bradley CB2225	4
R2	601-822295	Resistor, F. Comp., 2.7K, 1/4W, 5%	Allen Bradley CB2725	1
R4, 33	601-822531	Resistor, F. Comp., 33K, 1/4W, 5%	Allen Bradley CB3335	2
R5, 6, 36	601-822324	Resistor, F. Comp., 10K, 1/4W, 5%	Allen Bradley CB1035	3
R7, 11, 12, 18, 19, 28	601-822297	Resistor, F. Comp., 4.7K, 1/4W, 5%	Allen Bradley CB4725	6
R10, 25, 29, 32	601-822331	Resistor, F. Comp., 8.2K, 1/4W, 5%	Allen Bradley CB8225	4
R13	601-801803	Resistor, F. Comp., 12K, 1/4W, 5%	Allen Bradley CB1235	1
R14	601-822460	Resistor, F. Comp., 3.9K, 1/4W, 5%	Allen Bradley CB3925	1
R15, 22	601-822296	Resistor, F. Comp., 3.3K, 1/4W, 5%	Allen Bradley CB3325	2
R16	601-823387	Resistor, F. Comp., 47 Ω , 1/4W, 5%	Allen Bradley CB4705	1
R17	601-823916	Resistor, F. Comp., 1M, 1/4W, 5%	Allen Bradley CB1055	1
R20, 23, 31	601-822303	Resistor, F. Comp., 18K, 1/4W, 5%	Allen Bradley CB1835	3
R21	601-822299	Resistor, F. Comp., 6.8K, 1/4W, 5%	Allen Bradley CB6825	1
R24, 30, 34	601-822527	Resistor, F. Comp., 1.5K, 1/4W, 5%	Allen Bradley CB1525	3
R26, 27	601-822335	Resistor, F. Comp., 27K, 1/4W, 5%	Allen Bradley CB2735	2
R35	601-823902	Resistor, F. Comp., 47K, 1/4W, 5%	Allen Bradley CB4735	1
R37	601-822798	Resistor, F. Comp., 68K, 1/4W, 5%	Allen Bradley CB6835	1
R38	601-823397	Resistor, F. Comp., 5.6K, 1/4W, 5%	Allen Bradley CB5625	1

ACCESSORY COMMAND SCHEMATIC DIAGRAM



NOTES:

- 1) TRANSISTORS ARE AT755-425735, BECKMAN SPEC.
- 2) RESISTORS: - 1/4W, 5% UNLESS OTHERWISE NOTED
- 3) DIODES: - COB111 " " " " "
- 4) CAPACITANCE-IN PF " " " " "
- 5) * - DIODE IS AT755-420893, BECKMAN SPEC.



NOTE. Components indicated by arrows CR25, CR27, CR29, CR31, CR32, CR33, CR34, CR35, CR36, CR37, CR38, CR39, CR40, CR41, CR42, CR43, CR44, CR45, CR46, CR47, CR48, CR49, CR50, CR51, CR52, CR53, CR54, CR55, CR56, CR57, CR58, CR59, CR60, CR61, CR62, CR63, CR64, CR65, CR66, CR67, CR68, CR69, CR70, CR71, CR72, CR73, CR74, CR75, CR76, CR77, CR78, CR79, CR80, CR81, CR82, CR83, CR84, CR85, CR86, CR87, CR88, CR89, CR90, CR91, CR92, CR93, CR94, CR95, CR96, CR97, CR98, CR99, CR100 and R7,10,11,12 to be added to standard BI-OUT DCU D887-427792 to change it into 'Dj' Mod BI-QUI DCU D887-434231.

TEFLON SLEEVING

BI-QUINARY DCU (FWD. ONLY, w/GLO-TUBE & BCD READOUT) BOARD COMPONENT LAYOUT

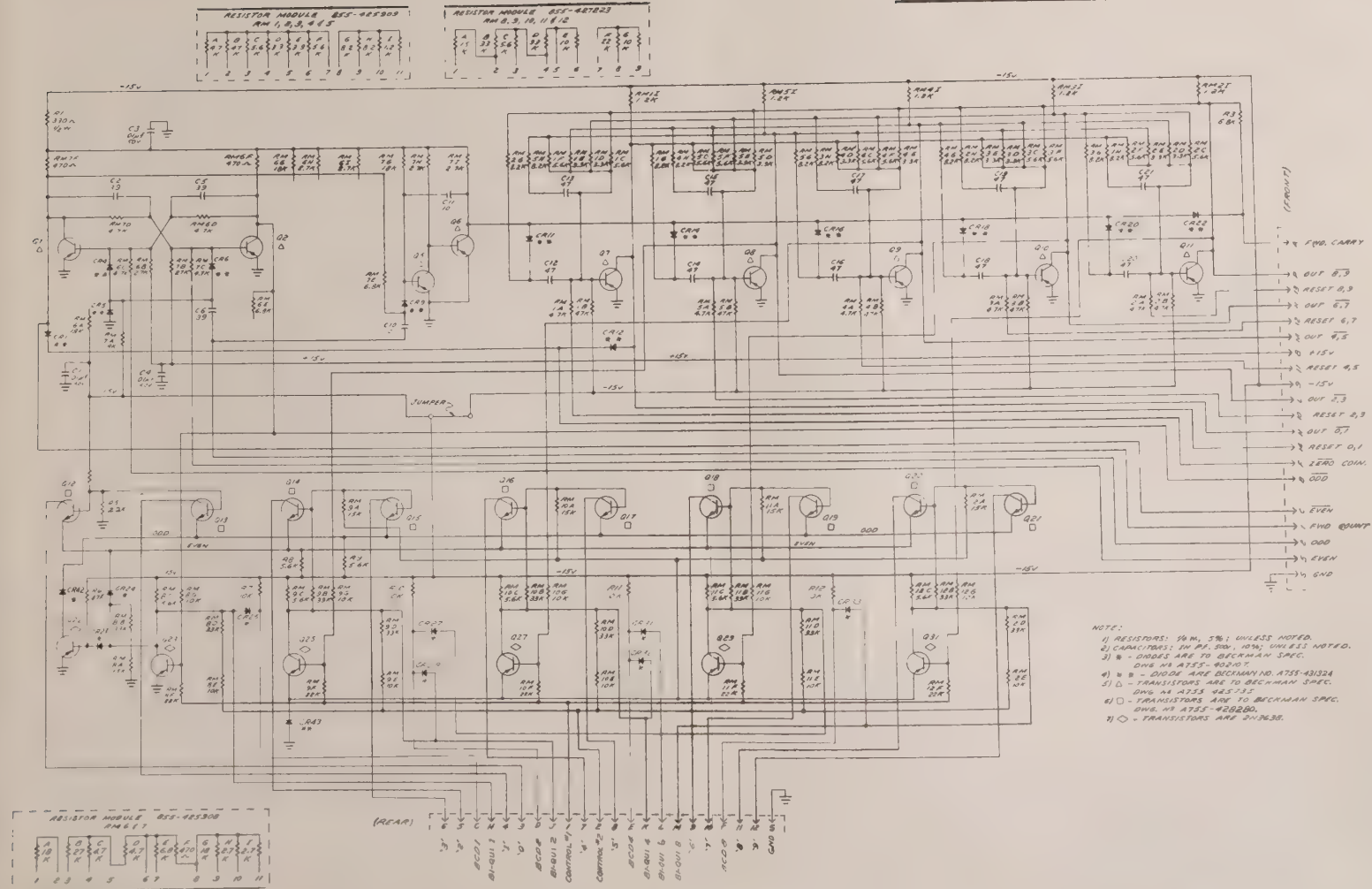
PARTS LIST

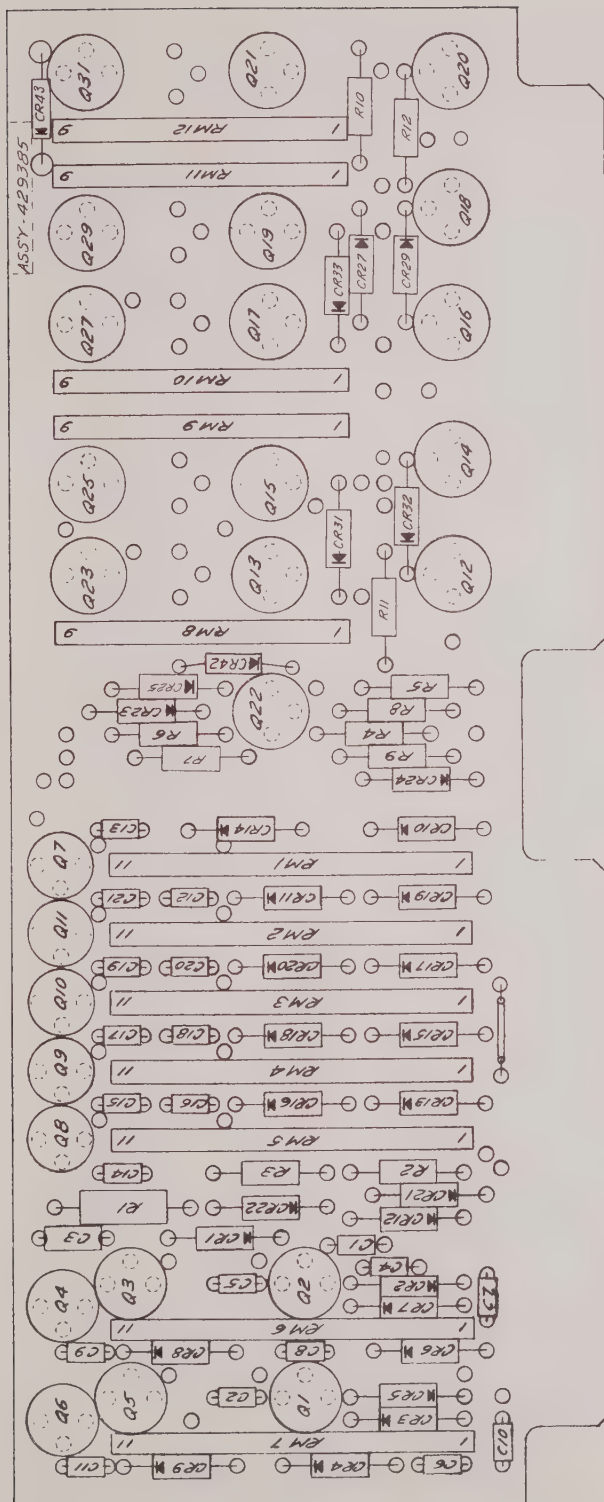
BI-QUINARY DCU (FWD. ONLY, w/GLO-TUBE & BCD READOUT)

(D434231-B)

<u>Detail No.</u>	<u>Beckman Stock No.</u>	<u>Description</u>	<u>Typical Manufacturer & No.</u>	<u>Qty./ Ass'y</u>
C1, 3, 4	633-804715	Capacitor, F. Cerm., 0.01 μ f, 50V	Sprague 19C214	3
C2, 5, 6	633-839570	Capacitor, F. Cerm., 39pf, 500V, 10%	Skottie TSD-4-390-K	3
C10, 11	633-839569	Capacitor, F. Cerm., 10pf, 500V, 10%	Skottie TSD-4-100-K	2
C12 thru C21	633-839568	Capacitor, F. Cerm., 47pf, 500V, 10%	Skottie TSD-4-470K	10
CR1, 4, 5, 6, 9, 11, 12, 14, 16, 18, 20, 22, 43	755-431324	Diode, Silicon	Beckman	13
CR23, 24, 25, 27, 29, 31, 32, 33, 42	755-402107	Diode, Silicon	Beckman	9
Q1, 2, 5, 6, 7, 8, 9, 10, 11	755-425735	Transistor, Special	Beckman	9
Q12 thru Q21	755-428280	Transistor, Special	Beckman	10
Q22, 23, 25, 27, 29, 31	755-838105	Transistor, Type 2N3638	Fairchild	6
R1	601-015443	Resistor, F. Comp., 330 Ω , 1/2W, 5%	Allen Bradley EB3315	1
R3	601-822299	Resistor, F. Comp., 6.8K, 1/4W, 5%	Allen Bradley CB6825	1
R4	601-822333	Resistor, F. Comp., 12K, 1/4W, 5%	Allen Bradley CB1235	1
R5	601-822328	Resistor, F. Comp., 2.2K, 1/4W, 5%	Allen Bradley CB2225	1
R6	601-823902	Resistor, F. Comp., 47K, 1/4W, 5%	Allen Bradley CB4735	1
R7, 10, 11, 12	601-822324	Resistor, F. Comp., 10K, 1/4W, 5%	Allen Bradley CB1035	4
R8, 9	601-822397	Resistor, F. Comp., 5.6K, 1/4W, 5%	Allen Bradley CB5625	2
RM1 thru RM5	885-425909	Resistor, Module	Beckman	5
RM6, 7	885-425908	Resistor, Module	Beckman	2
RM8 thru RM12	885-427223	Resistor, Module	Beckman	5
	864-811098	Transistor Pad	F. P. Adams	16

BI-QUINARY DCU
(FWD. ONLY, w/GLO-TUBE & BCD READOUT)
SCHEMATIC DIAGRAM





BI-QUINARY DCU (FWD. w/GLO-TUBE & BCD READOUT) BOARD
COMPONENT LAYOUT

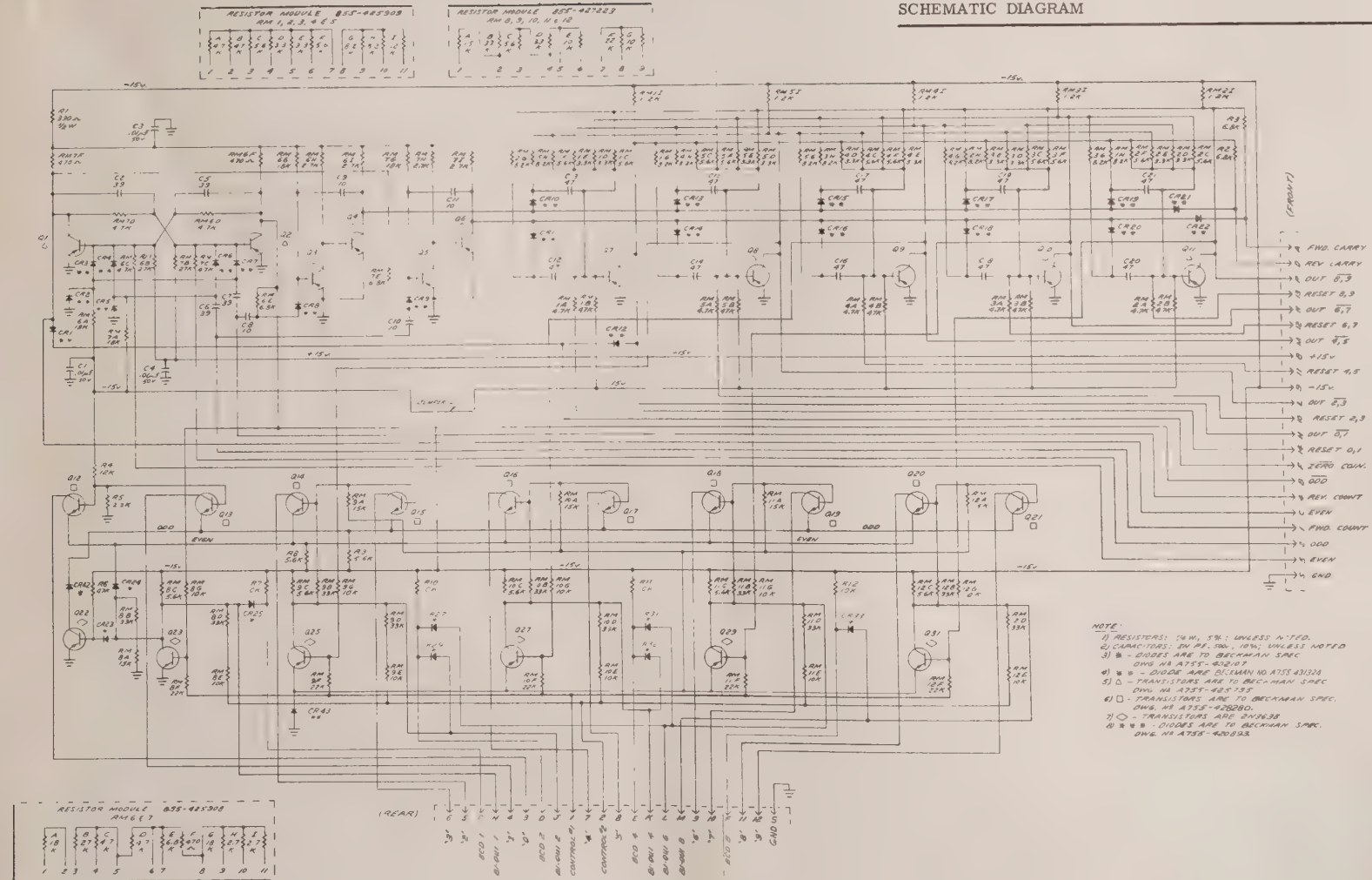
PARTS LIST

BI-QUINARY DCU (FWD./REV., w/GLO-TUBE & BCD READOUT)

(D429385-C)

<u>Detail No.</u>	<u>Beckman Stock No.</u>	<u>Description</u>	<u>Typical Manufacturer & No.</u>	<u>Qty./ Ass'y</u>
C1, 3, 4	633-804715	Capacitor, F.Cerm., 0.01 μ f, 50V	Sprague 19C214	3
C2, 5, 6, 7	633-839570	Capacitor, F.Cerm., 39pf, 500V, 10%	Skottie TSD-4-390-K	4
C8, 9, 10, 11	633-839569	Capacitor, F.Cerm., 10pf, 500V, 10%	Skottie TSD-4-100-K	4
C12, 13, 14, 15, 16, 17, 18, 19, 20, 21	633-839568	Capacitor, F.Cerm., 47pf, 500V, 10%	Skottie TSD-4-470K	10
CR1 thru CR22, CR43	755-431324	Diode, Silicon	Beckman	23
CR23, 24, 25, 27, 29, 31, 32, 33, 42	755-402107	Diode, Silicon	Beckman	9
Q1 thru Q11	755-425735	Transistor, Special	Beckman	11
Q12 thru Q21	755-428280	Transistor, Special	Beckman	10
Q22, 23, 25, 27, 29, 31	755-838105	Transistor, 2N3638	Fairchild	6
R1	601-015443	Resistor, F.Comp., 330 Ω , 1/2W, 5%	Allen Bradley EB3315	1
R2, 3	601-822299	Resistor, F.Comp., 6.8K, 1/4W, 5%	Allen Bradley CB6825	2
R4	601-822333	Resistor, F.Comp., 12K, 1/4W, 5%	Allen Bradley CB1235	1
R5	601-822328	Resistor, F.Comp., 2.2K, 1/4W, 5%	Allen Bradley CB2225	1
R6	601-823902	Resistor, F.Comp., 47K, 1/4W, 5%	Allen Bradley CB4735	1
R7, 10, 11, 12	601-822324	Resistor, F.Comp., 10K, 1/4W, 5%	Allen Bradley CB1035	4
R8, 9	601-822397	Resistor, F.Comp., 5.6K, 1/4W, 5%	Allen Bradley CB5625	2
RM1 thru RM5	855-425909	Resistor Module	Beckman	5
RM6, 7	855-425908	Resistor Module	Beckman	2
RM8 thru RM12	855-427223	Resistor Module	Beckman	5
	864-811098	Transistor Pad	F. P. Adams	16

BI-QUINARY DCU
(FWD./REV., w/GLO-TUBE & BCD READOUT)
SCHEMATIC DIAGRAM



CONTENTS
DM OPTION

	Page
TEXT	M-1
PARTS LIST	M-4
DIAGRAMS	
Overflow Board Component Layout (D 428750)	
Overflow Schematic Diagram (B 428751)	

ILLUSTRATION

Figure M-1. Wiring of the DCU and Overflow Boards	M-3
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DM OPTION

Addition of Sixth Digit and Overflow

GENERAL

The DM option adds a sixth digit and an overflow indication to the 6000 Series instruments. Thus the count capacity is increased from 10^5 to 10^6 counts.

SPECIFICATIONS

The DM option adds to the standard instrument in two ways:

- 1) Addition of a sixth digit to the readout DCU chain and to the actual readout. The added sixth DCU is identical to the other readout Binary DCU's. It acts as a complete count digit, becoming the most significant one in the readout chain. This addition does not impose any restriction on speed or performance.
- 2) The Overflow Board consists essentially of a flip-flop representing part of a seventh digit of the count chain. If the preceding sixth digit produces a forward carry, the overflow flip-flop will be set indicating that the accumulated count is in excess of 999999.

Once the count has exceeded 999999, the flip-flop is set and remains set even if reversing counts bring the total below 999999. The flip-flop remains set until the accumulator resets.

The overflow light in the legend block indicates that the flip-flop is set.

The overflow indication occurs simultaneously with the change of the displayed count (in either LATCH or FOLLOW).

An output overflow-indicating line is available:

No Overflow	(logic 0):	-10 to -15 volts.
Overflow	(logic 1):	0 to -0.8 volt.
Available current	(logic 0):	0.2 milliamperes.
	(logic 1):	5 milliamperes.

CIRCUITRY

The overflow circuitry of the DM option is shown in Overflow Schematic

-DM Option-

Diagram (dwg. no. B428751), and Overflow Board Component Layout (dwg. no. C428750). The extra DCU is identical to the DCU's that are in the standard instrument. For circuit information refer to the following diagrams in the standard instruction manual.

<u>Instrument No.</u>	<u>Schematic Diagram Drawing No.</u>	<u>Component Layout Drawing No.</u>
6003A, 6004A, 6005A	D427791	D427792
6013A, 6014A, 6015A	D427999	D428000
6010A, 6020A, 6030A	D427199	D427200

When the DM option is used with the DJ options, a sixth DCU is added which is identical to the DCU's used in the options. For circuit information on these DCU's, refer to the DJ options.

The wiring of the DCU Board and Overflow Board is shown in Figure M-1.

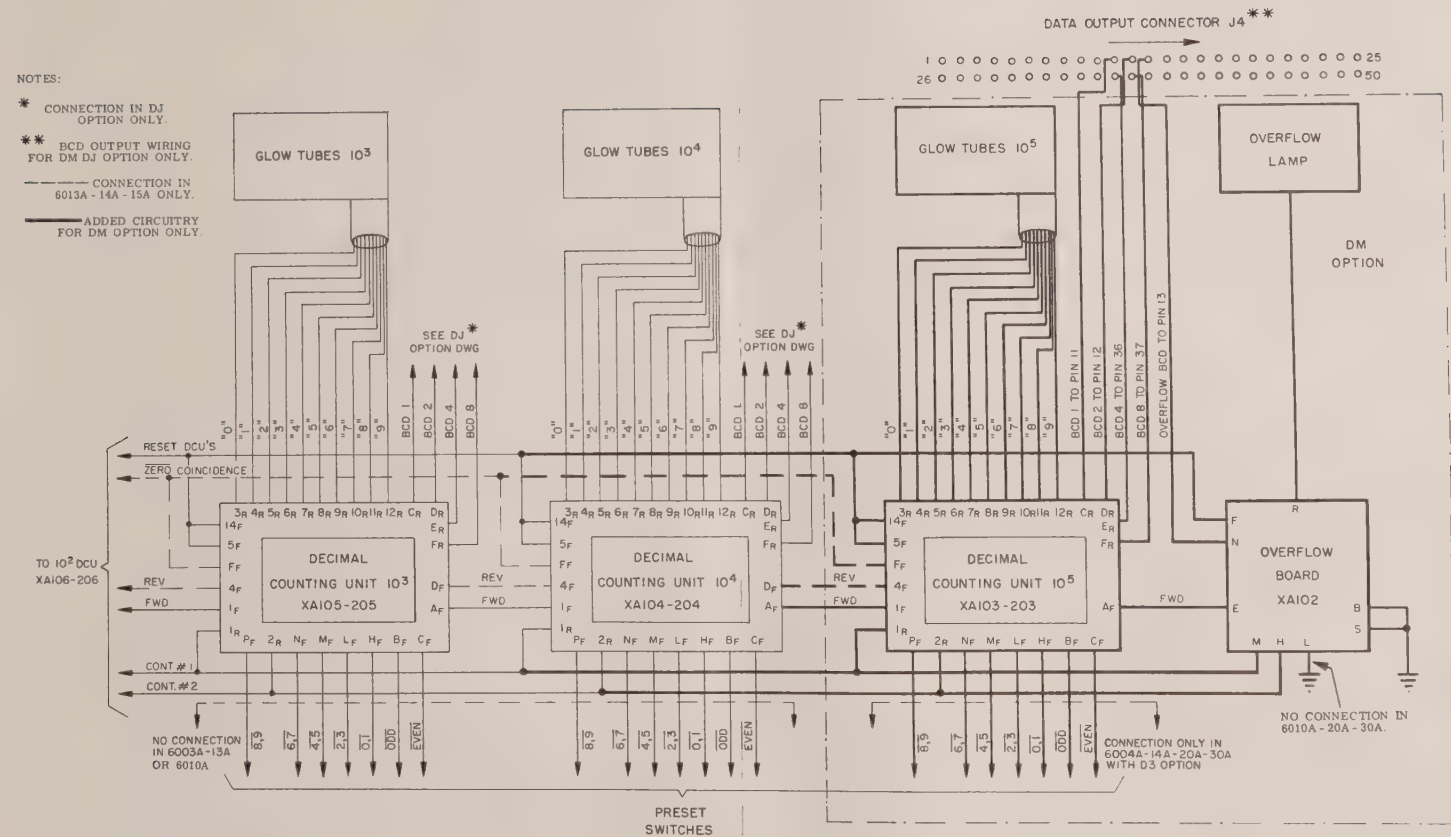
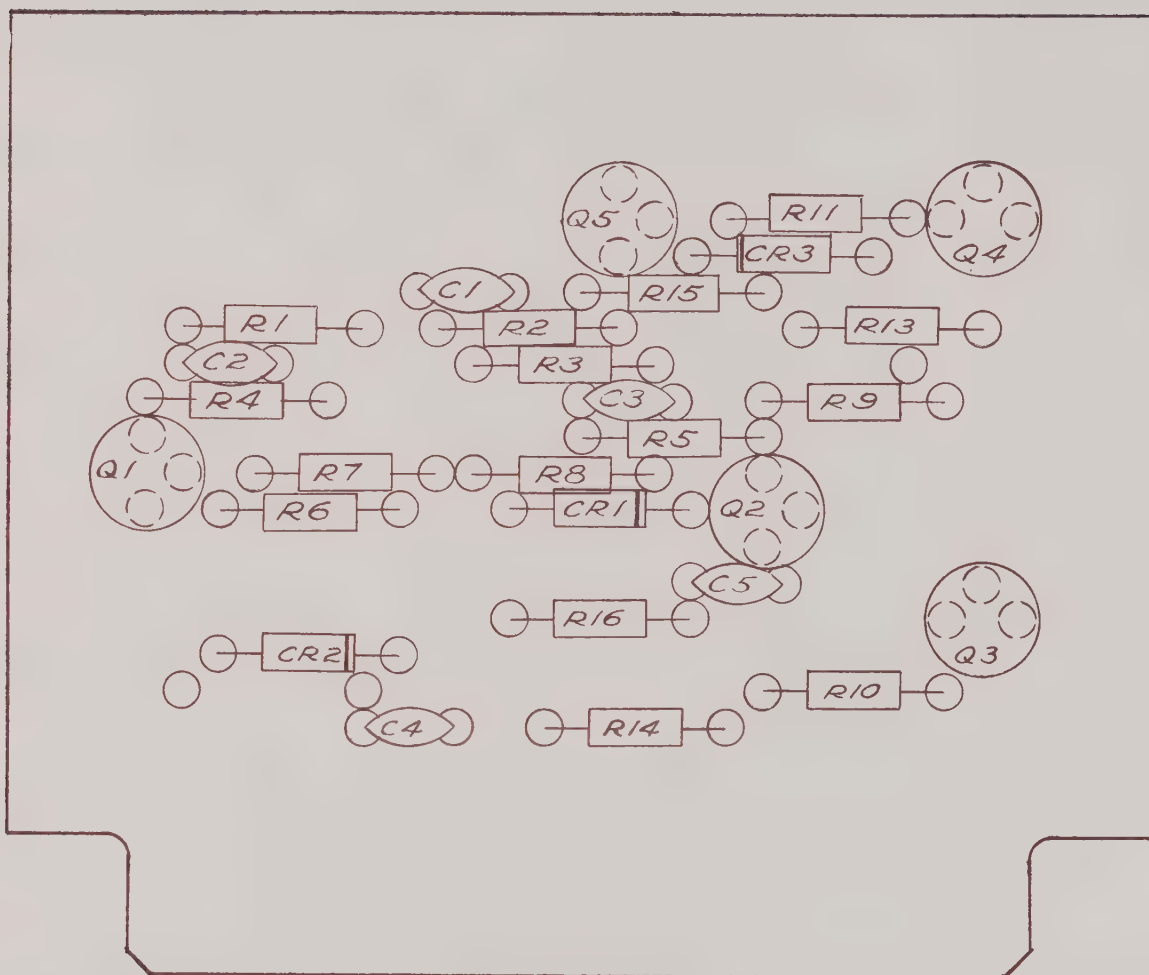


Fig. M-1. Wiring of the DCU and Overflow Boards.

(C428750-A)

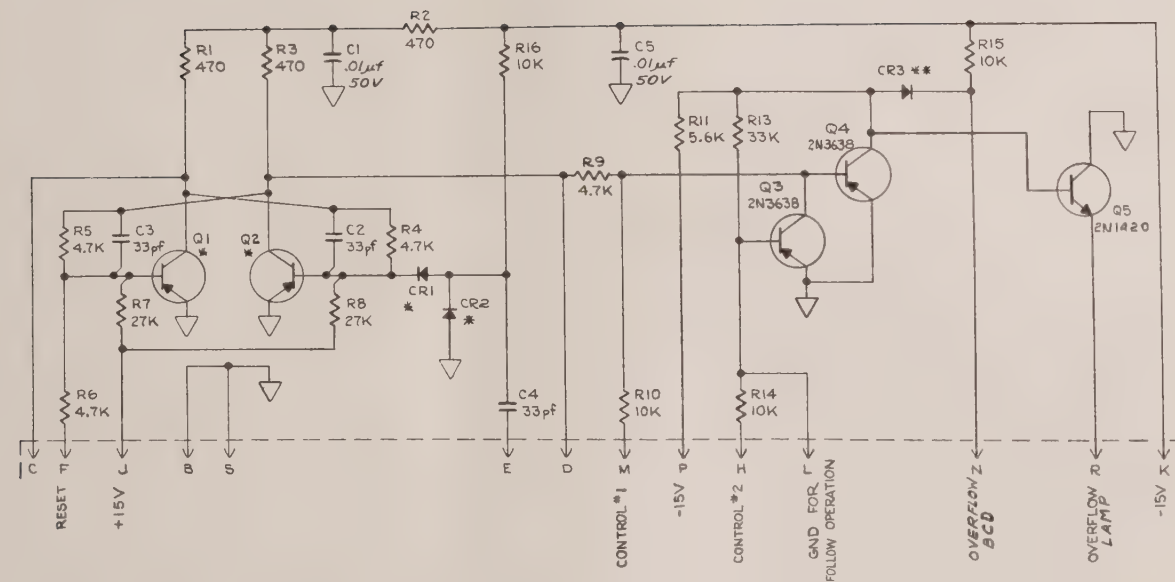
Parts List
Overflow Board Component Layout

<u>Detail No.</u>	<u>Beckman Stock No.</u>	<u>Description</u>	<u>Typical Manufacturer & No.</u>	<u>Qty./ Assy.</u>
C1	633-804715	Capacitor, F., Cerm., 0.01 μ f, 50V	Sprague 19C214	2
C2	633-838426	Capacitor, F., Cerm., 33pf, 500V	Skottie TSD-4-330-K	3
C3 & C4		Same as C2		
C5		Same as C1		
CR1	755-431324	Diode, Special	Beckman	2
CR2		Same as CR1		
CR3	755-402107	Diode, Special	Beckman	1
Q1	755-425735	Transistor, Special	Beckman	2
Q2		Same as Q1		
Q3	755-838105	Transistor, 2N3638	Fairchild	2
Q4		Same as Q3		
Q5	755-817964	Transistor, 2N1420	Texas Instr.	1
R1	601-823395	Resistor, F., Comp., 470 Ω , 1/4W, 5%	Allen Bradley CB4715	3
R2 & R3		Same as R1		
R4	601-822297	Resistor, F., Comp., 4.7K, 1/4W, 5%	Allen Bradley CB4725	4
R5 & R6		Same as R4		
R7	601-822335	Resistor, F., Comp., 27K, 1/4W, 5%	Allen Bradley CB2735	2
R8		Same as R7		
R9		Same as R4		
R10	601-822324	Resistor, F., Comp., 10K, 1/4W, 5%	Allen Bradley CB1035	4
R11	601-823397	Resistor, F., Comp., 5.6K, 1/4W, 5%	Allen Bradley CB5625	1
R13	601-822531	Resistor, F., Comp., 33K, 1/4W, 5%	Allen Bradley CB3335	1
R14 thru R16		Same as R10		



OVERFLOW BOARD COMPONENT LAYOUT

OVERFLOW SCHEMATIC DIAGRAM



NOTE:

1 - RESISTORS
1/4W, 5% EXCEPT AS NOTED

2 - TRANSISTORS:
* BECKMAN SPEC., 755-425735

3 - DIODES:
* BECKMAN SPEC., 755-431324
** " " " 755-402107

CONTENTS
DP OPTION

	Page
TEXT	P-1
PARTS LIST	P-4
DIAGRAMS	
Anti-Coincidence Component Layout	D 425609
Anti-Coincidence Schematic Diagram	D 425593

ILLUSTRATIONS

Figure	
P-1 Timing Diagram	P-2
P-2 Logic Diagram	P-3

DP OPTION

Anti-Coincidence Board

GENERAL

The DP option is an anti-coincidence board designed for use with the reversing type 6000A Series Accumulators, Models 6013A, 6014A, and 6015A. The DP option provides proper operation when X and Y inputs occur simultaneously or too closely together to be resolved by the basic unmodified instrument.

SPECIFICATIONS

The separation between closely spaced X and Y inputs is accomplished by using a 1.2 MHz square wave generator (astable multivibrator). Operation depends on the selected mode (X, X+Y, or X-Y). Results for these three operating modes are shown in Figure P-1, Timing Diagram. Figure P-2 is a logic diagram of the anti-coincidence circuitry.

In order to demonstrate the usefulness of the DP option, input limitations are given below for the accumulator with and without the option.

Without DP option:

- a) In X+Y mode, any input (either X or Y) must not follow the preceding input (either X or Y) by less than 0.5 microsecond.
- b) In X-Y mode, any input which causes change in the previous direction of count must not follow the preceding input by less than 1.0 microsecond.

With DP option:

In either X+Y or X-Y mode, signals on the same channel must be separated by at least 1.0 microsecond, but any phasing is permissible between X and Y inputs, including simultaneous occurrence.

NOTE

The rules for normal operation apply when resetting or counting through zero.

CIRCUITRY

Refer to the Anti-Coincidence Schematic Diagram (dwg. no. D425593), and Anti-Coincidence Component Layout Board (dwg. no. D425609).

For the electrical components contained in the assembly refer to the parts list.

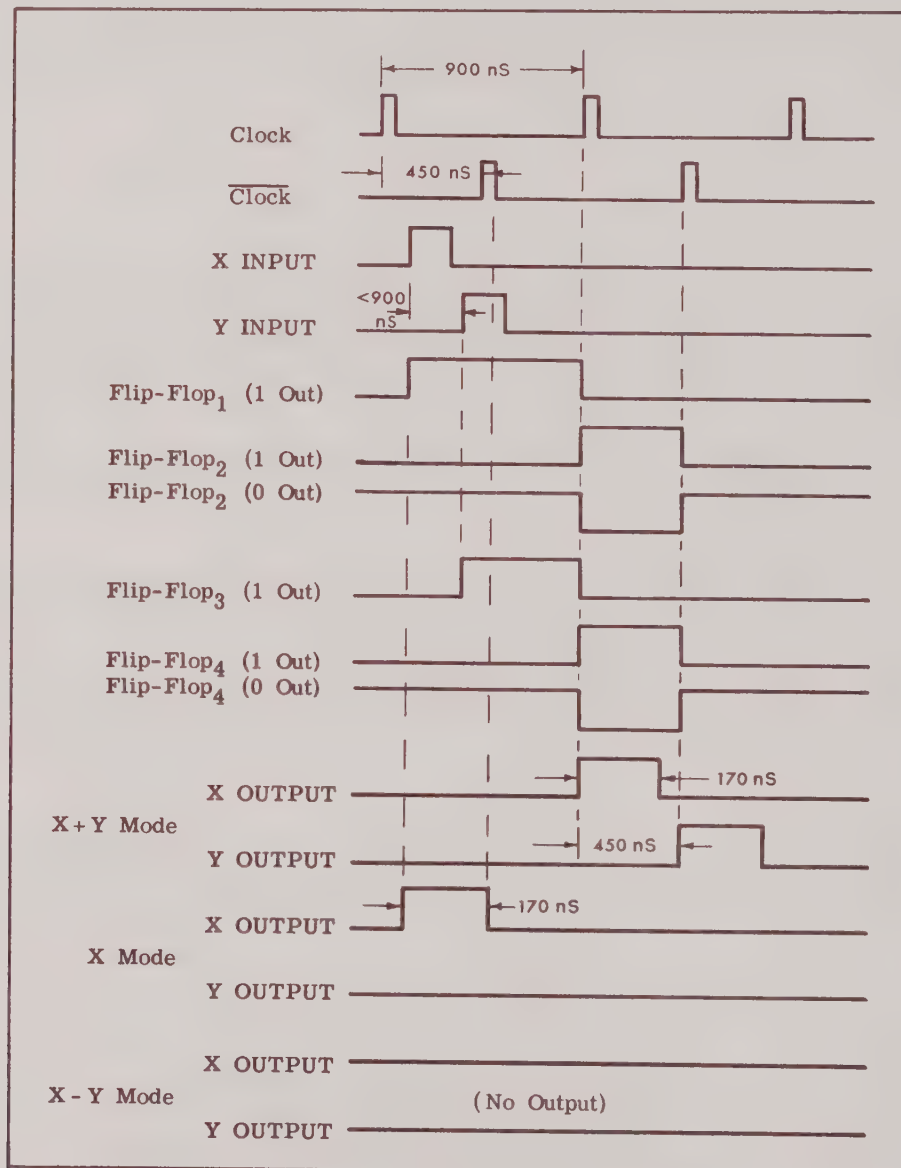


Fig. P-1. Timing Diagram

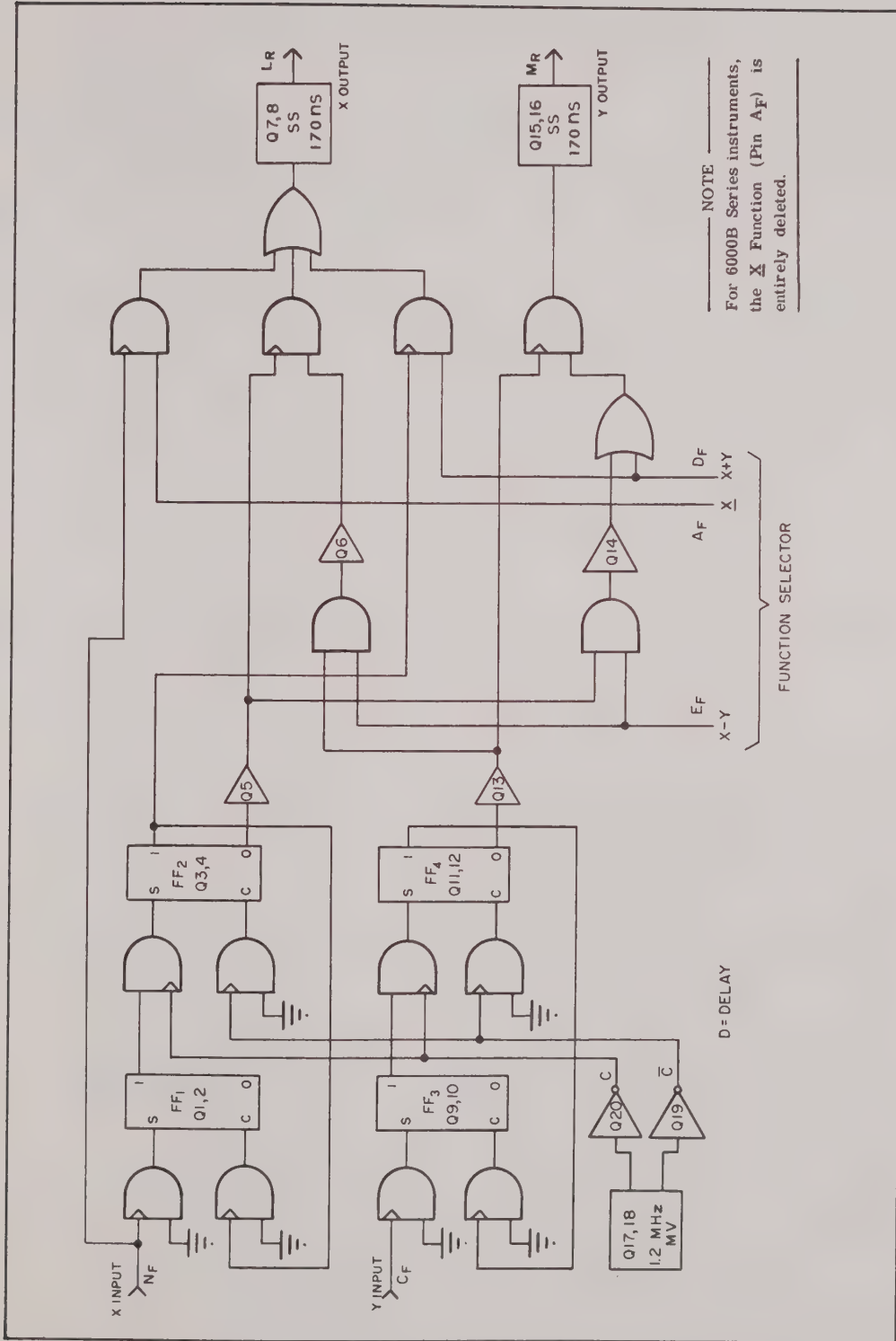


Fig. P-2. Logic Diagram

(D425609-D)

Parts List
Anti-Coincidence Board

<u>Detail No.</u>	<u>Beckman Stock No.</u>	<u>Description</u>	<u>Typical Manufacturer & No.</u>	<u>Qty./ Ass'y</u>
C1	633-804715	Capacitor, Cerm., 0.01 μ f, 50V	Sprague 19C214	12
C2	633-838425	Capacitor, Cerm., 22pf, 500V, 10%	Skottie TSD-4-220-K	12
C3 & C4		Same as C2		
C5	633-838426	Capacitor, Cerm., 33pf, 500V, 10%	Skottie TSD-4-330-K	6
C6		Same as C1		
C7 & C8		Same as C2		
C9		Same as C5		
C10		Same as C2		
C11		Same as C14		
C12 & C13		Same as C5		
C14	633-839568	Capacitor, F. Cerm., 47pf, 500V, 10%	Skottie TSD-4-470-K	4
C15		Same as C1		
C16 thru C18		Same as C2		
C19		Same as C5		
C20		Same as C1		
C21 & C22		Same as C2		
C23		Same as C5		
C24		Same as C2		
C25 & C26		Same as C14		
C27 & C28	637-836048	Capacitor, F. Mica 130pf, 500V, 5%	Electromotive DM15F131J	2
C29 & C30		Same as C1		
C31 & C32	633-836932	Capacitor, F. Cerm., 100pf, 500V, 10%	Skottie TSD-4-101-K	2
C33 thru C38		Same as C1		

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Parts List
Anti-Coincidence Board (continued)

<u>Detail No.</u>	<u>Beckman Stock No.</u>	<u>Description</u>	<u>Typical Manufacturer & No.</u>	<u>Qty./ Ass'y</u>
CR1 thru CR8	755-430324	Diode, Special	Beckman	23
CR10 thru CR22		Same as CR1		
CR24 & CR25		Same as CR1		
Q1 thru Q4	755-425735	Transistor, Special	Beckman	14
Q5 & Q6	755-419596	Transistor, Special	Beckman	6
Q7 thru Q12		Same as Q1		
Q13 & Q14		Same as Q5		
Q15 & Q16		Same as Q1		
Q17 & Q18		Same as Q5		
Q19 & Q20		Same as Q1		
R1	601-822371	Resistor, F. Comp. , 390 Ω , 1/4W, 5%	Allen Bradley CB3915	4
R2	601-823395	Resistor, F. Comp. , 470 Ω , 1/4W, 5%	Allen Bradley CB4715	10
R3	601-822296	Resistor, F. Comp. , 3.3K, 1/4W, 5%	Allen Bradley CB3325	16
R4	601-822527	Resistor, F. Comp. , 1.5K, 1/4W, 5%	Allen Bradley CB1525	5
R5 & R6	601-822335	Resistor, F. Comp. , 27K, 1/4W, 5%	Allen Bradley CB2735	8
R7		Same as R2		
R8 & R9		Same as R3		
R10		Same as R1		
R11		Same as R2		
R12 & R13		Same as R3		
R14 & R15		Same as R5		
R16		Same as R2		

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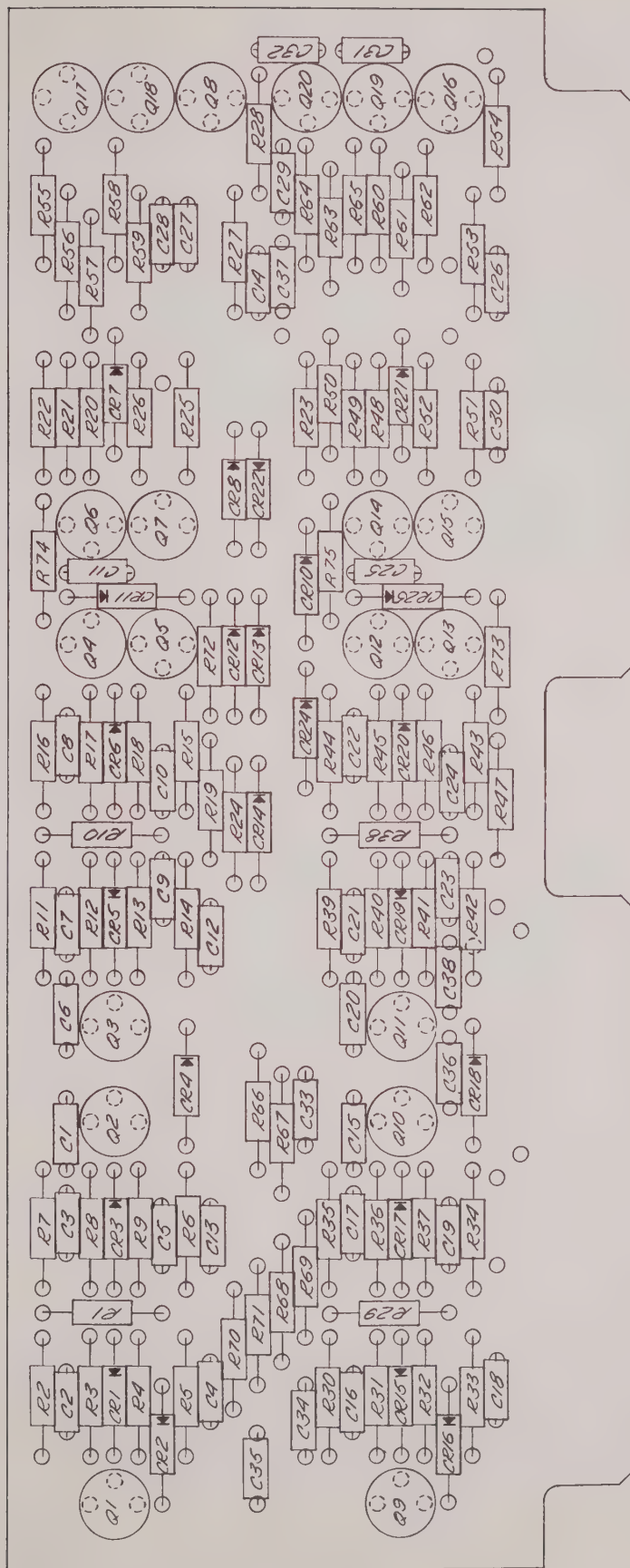
Parts List
Anti-Coincidence Board (continued)

<u>Detail No.</u>	<u>Beckman Stock No.</u>	<u>Description</u>	<u>Typical Manufacturer & No.</u>	<u>Qty./ Ass'y</u>
R17 & R18		Same as R3		
R19	601-823397	Resistor, F. Comp., 5.6K, 1/4W, 5%	Allen Bradley CB5625	4
R20	601-822531	Resistor, F. Comp., 33K, 1/4W, 5%	Allen Bradley CB3335	2
R21		Same as R19		
R22 thru R25	601-822324	Resistor, F. Comp., 10K, 1/4W, 5%	Allen Bradley CB1035	9
R26	601-822297	Resistor, F. Comp., 4.7K, 1/4W, 5%	Allen Bradley CB4725	2
R27	601-822306	Resistor, F. Comp., 820Ω, 1/4W, 5%	Allen Bradley CB8215	2
R28	601-823396	Resistor, F. Comp., 560Ω, 1/4W, 5%	Allen Bradley CB5615	2
R29		Same as R1		
R30		Same as R2		
R31		Same as R3		
R32		Same as R4		
R33 & R34		Same as R5		
R35		Same as R2		
R36 & R37		Same as R3		
R38		Same as R1		
R39		Same as R2		
R40 & R41		Same as R3		
R42 & R43		Same as R5		
R44		Same as R2		
R45 & R46		Same as R3		
R47		Same as R19		
R48		Same as R20		
R49		Same as R19		
R50 & R51		Same as R22		

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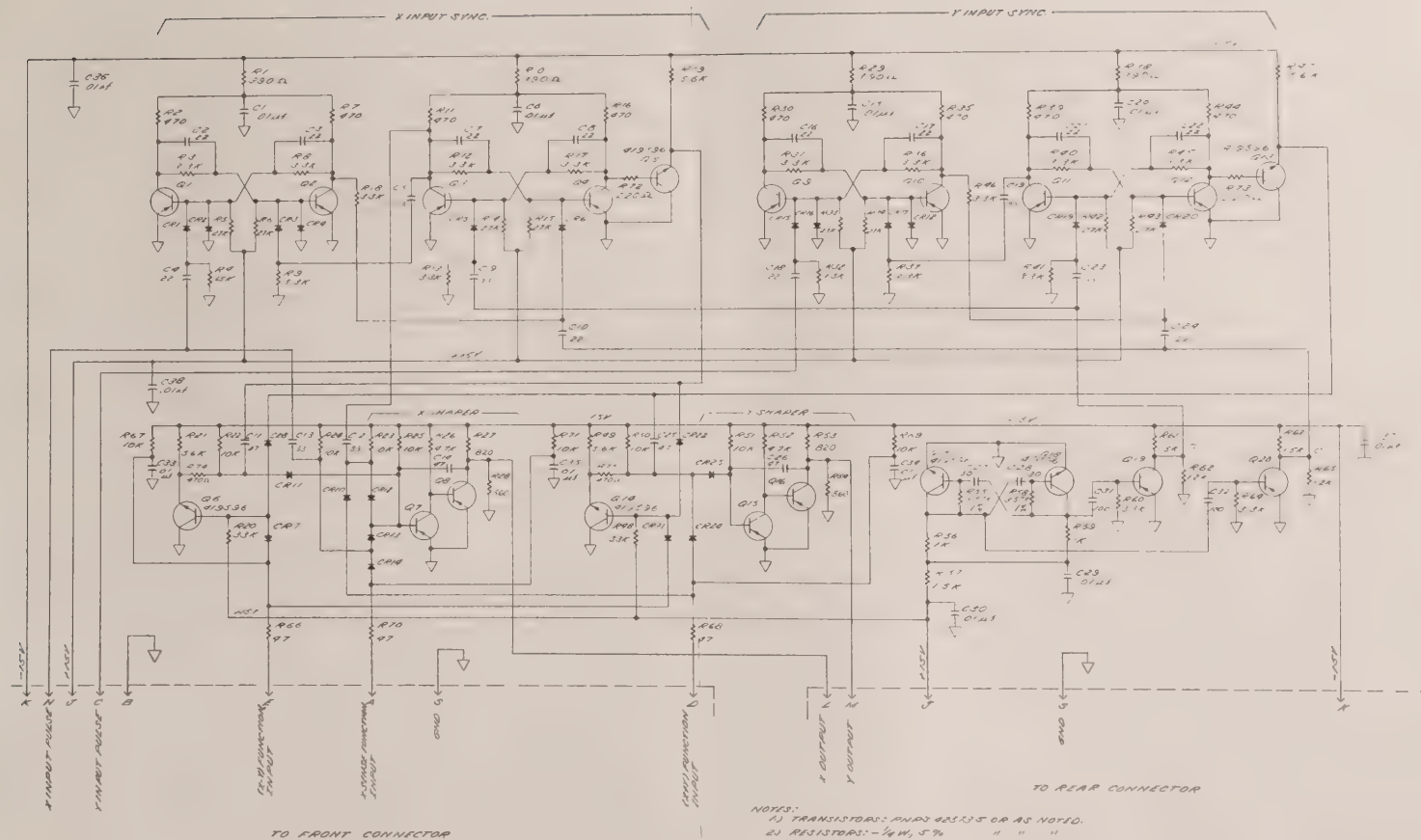
Parts List
Anti-Coincidence Board (continued)

<u>Detail No.</u>	<u>Beckman Stock No.</u>	<u>Description</u>	<u>Typical Manufacturer & No.</u>	<u>Qty./ Ass'y</u>
R52		Same as R26		
R53		Same as R27		
R54		Same as R28		
R55	607-842080	Resistor, F.F., 3.57K, 1/4W, 1%	IRC-CEB-TO	2
R56	601-822308	Resistor, F. Comp., 1K, 1/4W, 5%	Allen Bradley CB1025	2
R57		Same as R4		
R58		Same as R55		
R59		Same as R56		
R60		Same as R3		
R61		Same as R4		
R62	601-822326	Resistor, F. Comp., 1.2K, 1/4W, 5%	Allen Bradley CB1225	2
R63		Same as R4		
R64		Same as R3		
R65		Same as R62		
R66	601-823387	Resistor, F. Comp., 47 Ω , 1/4W, 5%	Allen Bradley CB4705	3
R67		Same as R22		
R68		Same as R66		
R69		Same as R22		
R70		Same as R66		
R71		Same as R22		
R72 & R73	601-822327	Resistor, F. Comp., 220 Ω , 1/4W, 5%	Allen Bradley CB2215	2
R74 & R75		Same as R2		



ANTI-COINCIDENCE BOARD COMPONENT LAYOUT

ANTI-COINCIDENCE SCHEMATIC DIAGRAM



- NOTES:
- 1) TRANSISTORS: PNP 9213'S OR AS NOTED.
 - 2) RESISTORS: $\frac{1}{4}$ W, 5% " " "
 - 3) DIODES: - 1N5064 (COSH) " " "
 - 4) CAPACITANCES: - 100P " " "

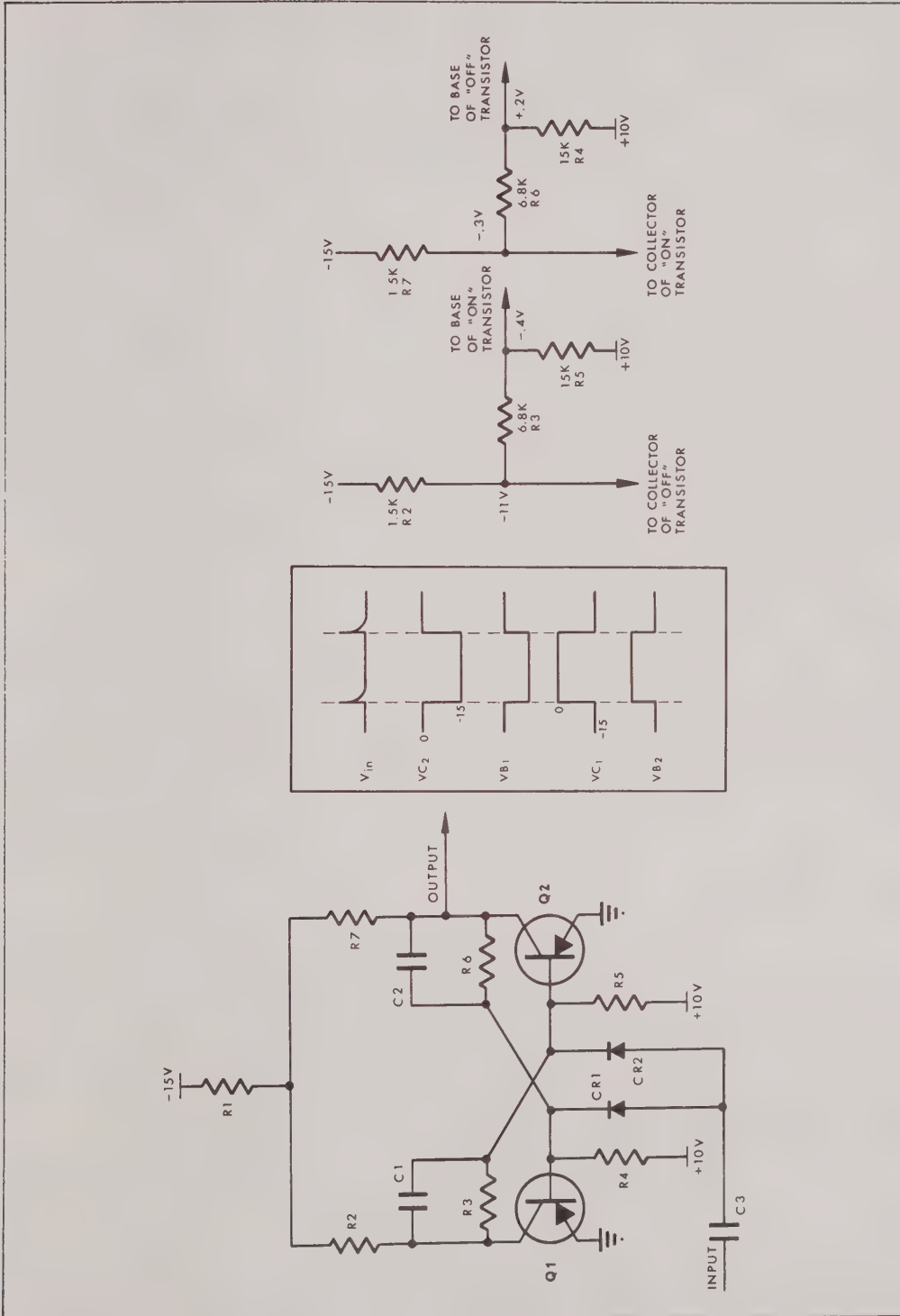


Fig. A-8A. Positive Pulse Steering

A.9 SINGLE-SHOT (MONOSTABLE) MULTIVIBRATOR

A typical single-shot (monostable) multivibrator is shown in figure A-9. Transistor Q1 is held at cutoff and transistor Q2 at saturation by bias arrangement and transistor regeneration. When a negative pulse is applied at the input, the circuit functions until a full cycle is complete. Circuit timing is determined by the values of capacitor C1 and resistor R2.

Single-Shot Circuit Description

A negative pulse is applied through coupling capacitor C2 to the base of transistor Q1, and it begins to conduct. The negative voltage at the collector of Q1 begins to fall. This positive transient is coupled to the base of transistor Q2, and forward bias on Q2 is decreased. Collector current of Q2 begins to decrease, and its collector voltage increases negatively. Part of this voltage is coupled through R4 to the base of Q1, increasing its negative potential. This regeneration results in a rapid change of both transistors; it drives Q1 into saturation and Q2 into cutoff. Since capacitor C1 was initially charged to -15 volts, the base of Q2 is at a positive potential of that magnitude (15 volts).

Capacitor C1 begins to discharge through R2 and the low resistance of Q1, and base potential of Q2 becomes less positive. When the base of Q2 becomes slightly negative, Q2 again conducts. Collector potential of Q2 increases positively and is coupled to the base of transistor Q1, driving it to cutoff. Transistor Q1 is again at cutoff and Q2 at saturation. This stable state is maintained until another negative pulse arrives to trigger the circuit.

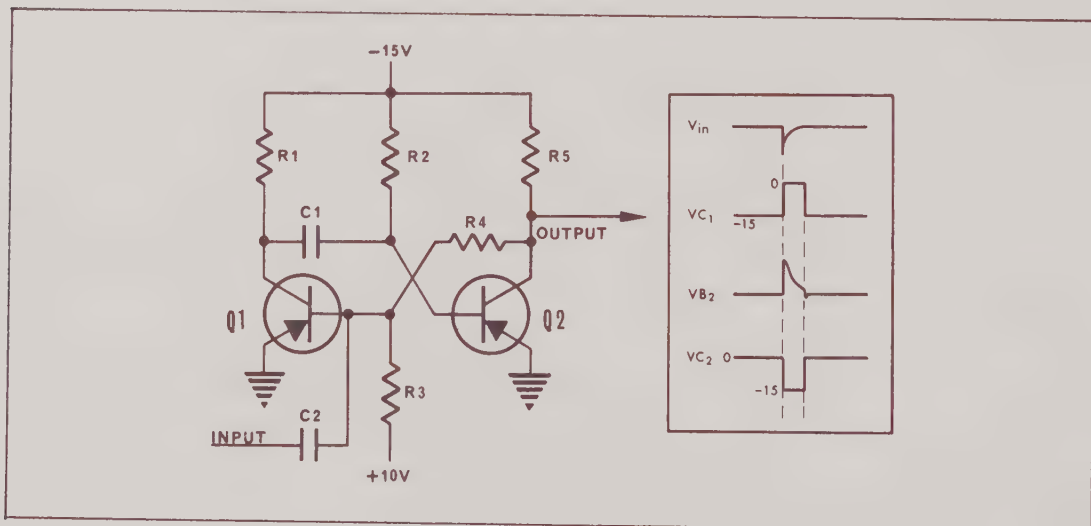


Fig. A-9. Typical Single-Shot Circuit

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